RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 52 APRIL, 1949 No. 4

CONTENTS

ARTHROGRAMS. *H. Kelikian, M.D., and Elbert Kenneth Lewis, M.D.* 465

ELECTROKYMOGRAPHY OF THE HEART AND GREAT VESSELS: CORRELATION WITH ROENTGENKYMOGRAPHY IN CLINICAL CASE STUDIES. *Herbert M. Stauffer, M.D., and Joseph Jorgens, M.D.* 488

EVALUATION OF NEEDLE ASPIRATION TECHNIC IN BREAST LESIONS. *John W. Budd, M.D.* 502

VALUE AND LIMITATIONS OF ASPIRATION BIOPSY FOR LUNG LESIONS. *George P. Rosemond, M.D., W. Emory Burnett, M.D., and John H. Hall, M.D.* 506

DIAGNOSIS OF BRONCHOGENIC CARCINOMA BY CYTOLOGIC METHODS. *Seymour M. Farber, M.D., Mortimer A. Benioff, M.D., and Allen K. McGrath, Jr., M.D.* 511

MINIMAL TUBERCULOSIS. PROBLEMS IN ROENTGEN INTERPRETATION. *I. D. Bobrowitz, M.D., and Allan Hurst, M.D.* 519

RADIUM THERAPY IN CARCINOMA OF THE FEMALE URETHRA. *Robert E. Fricke, M.D., and James T. McMillan, M.D.* 533

CARCINOMA OF THE THYROID GLAND. *William E. Howes, M.D., and Merrill N. Foote, M.D.* 541

GRAVES' DISEASE. TWENTY-FIVE-YEAR FOLLOW-UP OF CASES RECEIVING ROENTGEN THERAPY. *J. Marion Read, M.D.* 557

ROENTGEN THERAPY OF CARCINOMA OF THE SKIN OF THE EYELIDS. *J. A. del Regato, M.D.* 564

EFFECTS OF RADIATION THERAPY ON THE URINARY EXCRETION OF NIACIN AND RIBOFLAVIN IN PATIENTS WITH MALIGNANT DISEASES. RELATIONSHIP TO RADIATION SICKNESS. *J. L. Jarvis, M.D., and David Cayer, M.D.* 574

ANTI-HISTAMINE OINTMENTS FOR SKIN PROTECTION IN RADIOTHERAPY. *M. Paul Mains, M.D.* 579

EDITORIALS: SEGMENTAL ANATOMY OF THE LUNG. *Leo G. Rigler, M.D.* 582

THE IDENTIFICATION OF CARCINOMA OF THE LUNG. *Leo G. Rigler, M.D.* 583

ANNOUNCEMENTS AND BOOK REVIEWS. 585

IN MEMORIAM 587

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES. 589

ABSTRACTS OF CURRENT LITERATURE. 592

RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

EDITOR
Howard P. Doub, M.D.
Henry Ford Hospital, Detroit 2, Mich.

ASSOCIATE EDITORS
John D. Camp, M.D.
Hugh F. Hare, M.D.

EDITORIAL ASSISTANT
Marion B. Crowell, A.B.

PUBLICATION COMMITTEE
George L. Sackett, M.D., Chairman
Harold W. Jacox, M.D.
Leo G. Rigler, M.D.

GENERAL INFORMATION

RADIOLOGY is entered as second class matter at Syracuse, New York, and Easton, Penna., under the Act of August 24, 1912, and accepted November 24, 1934. RADIOLOGY is published by the Radiological Society of North America as its official Journal. Subscription rate $8.00 per annum. Canadian postage, $1.00 additional. Foreign postage, $2.00 additional. Single copies $1.00 each. All correspondence relative to business matters connected with the Radiological Society of North America and RADIOLOGY, or remittance for non-member subscriptions, should be made payable to the Radiological Society of North America and should be addressed to the BUSINESS MANAGER, DONALD S. CHILDS, M.D., 713 E. GENESEE STREET, SYRACUSE 2, NEW YORK. In requesting change of address, both the old and the new address should be given.

Dues to the Radiological Society of North America include subscription to RADIOLOGY and should be paid to DONALD S. CHILDS, M.D., SECRETARY-TREASURER, 713 E. GENESEE STREET, SYRACUSE 2, N. Y.

The rate for "want" advertisements for insertion in the Classified Section is 8 cents per word, minimum charge $2.00. Remittance should accompany order. Rates for display advertisements will be furnished upon request.

Inquiries regarding the program for the Annual Meeting of the Society for the current year should be sent to the President.

RADIOLOGY is published under the supervision of the Publication Committee of the Radiological Society of North America, who reserve the right to reject any material submitted for publication, including advertisements. No responsibility is accepted by the Committee or the Editor for the opinions expressed by the contributors, but the right is reserved to introduce such changes as may be necessary to make the contributions conform to the editorial standards of RADIOLOGY. Correspondence relating to publication of papers should be addressed to the Editor, HOWARD P. DOUB, M.D., HENRY FORD HOSPITAL, DETROIT 2, MICHIGAN.

Original articles will be accepted only with the understanding that they are contributed solely to RADIOLOGY. Articles in foreign languages will be translated if they are acceptable. Manuscripts should be typewritten, double-spaced, with wide margins, on good paper, and the original, not a carbon copy, should be submitted. The author's full address should appear on the manuscript. It is advisable that a copy be retained for reference as manuscripts will not be returned.

Illustrations and tables should be kept within reasonable bounds, as the number which can be published without cost to the author is strictly limited. For excess figures and for illustrations in color, estimates will be furnished by the Editor. Photographic prints should be clear and distinct and on glossy paper. Drawings and charts should be in India ink on white or on blue-lined coordinate paper. Blueprints will not reproduce satisfactorily. All photographs and drawings should be numbered, the top should be indicated, and each should be accompanied by a legend with a corresponding number. Authors are requested to indicate on prints made from photomicrographs the different types of cells to which attention is directed, by drawing lines in India ink and writing in the margin. The lines will be reproduced, and the words will be set in type. Attention should be called to points which should be brought out in completed illustrations, by tracings and suitable texts. These instructions should be concise and clear.

As a convenience to contributors to RADIOLOGY who are unable to supply prints for their manuscripts, the Editor can arrange for intermediate prints from roentgenograms.

The Society will furnish fifty reprints to authors, for which arrangements must be made with the Editor.

Contents of RADIOLOGY copyrighted 1949 by The Radiological Society of North America, Inc.

OFFICERS OF THE
RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC.

EDGAR P. MCNAMEE, M.D.	*President*	Cleveland, Ohio
WARREN W. FUREY, M.D.	*President-Elect*	Chicago, Illinois
LAURENCE L. ROBBINS, M.D.	*First Vice-President*	Boston, Massachusetts
EARL R. MILLER, M.D.	*Second Vice-President*	San Francisco, Calif.
JAMES N. COLLINS, M.D.	*Third Vice-President*	Indianapolis, Indiana
DONALD S. CHILDS, M.D.	*Secretary-Treasurer*	Syracuse, New York
HOWARD P. DOUB	*Librarian*	Detroit, Michigan

BOARD OF DIRECTORS

JOHN S. BOUSLOG, M.D., *Chairman*, Denver, Colorado . . . retires in 1949
JOSEPH C. BELL, M.D., Louisville, Kentucky . . . retires in 1950
IRA H. LOCKWOOD, M.D., Kansas City, Missouri . . . retires in 1951
EUGENE P. PENDERGRASS, M.D., Philadelphia, Pennsylvania . . . retires in 1952
EDGAR P. MCNAMEE, M.D., Cleveland, Ohio . . . President
WARREN W. FUREY, M.D., Chicago, Illinois . . . President-Elect

EDITOR

HOWARD P. DOUB, M.D. . . . Detroit, Michigan

ASSOCIATE EDITORS

JOHN D. CAMP, M.D. . . . Rochester, Minnesota
HUGH F. HARE, M.D. . . . Boston, Massachusetts

COMMITTEES FOR 1949

NECROLOGY COMMITTEE
ARTHUR J. HORRIGAN, M.D., *Chairman*, Springfield, Massachusetts
JUSTINE E. MCCARTHY, M.D., Cincinnati, Ohio
E. KENNETH LEWIS, M.D., Chicago, Illinois
RALPH BACON, M.D., Erie, Pennsylvania

PHYSICS COMMITTEE
LAURISTON S. TAYLOR, Ph.D., *Chairman*, Bethesda, Maryland
URSUS V. PORTMANN, M.D., *Sub-Chairman*, Cleveland, Ohio
Physicians:
EDWIN C. ERNST, M.D., St. Louis, Missouri
ROBERT R. NEWELL, M.D., San Francisco, California
ROBERT B. TAFT, M.D., Charleston, South Carolina
AXEL N. ARNESON, M.D., St. Louis, Missouri
RICHARD H. CHAMBERLAIN, M.D., Philadelphia, Pennsylvania
SYDNEY F. THOMAS, M.D., Menlo Park, California
Physicists:
OTTO GLASSER, Ph.D., Cleveland, Ohio
EDITH H. QUIMBY, Sc.D., New York, New York
J. L. WEATHERWAX, M. A., Philadelphia, Pennsylvania
GEORGE C. LAURENCE, Ph.D., Chalk River, Ontario, Canada
GEORGE C. HENNY, M.S., Philadelphia, Pennsylvania
KENNETH E. CORRIGAN, Ph.D., Detroit, Michigan

MEMBERSHIP COMMITTEE
President-Elect—WARREN W. FUREY, M.D., *Chairman*, Chicago, Illinois
Members of the Board of Counselors

MEDICO-LEGAL COMMITTEE
SAM DONALDSON, M.D., *Chairman*, Ann Arbor, Michigan
GERARD RAAP M.D., Miami, Florida
LUCAS S. HENRY, M.D., Syracuse, New York
JOHN E. HABBE, M.D., Milwaukee, Wisconsin
WILBUR BAILEY, M.D., Los Angeles, California

PUBLICITY AND EDUCATION COMMITTEE
DONALD S. CHILDS, M.D., *Chairman*, Syracuse, New York
HARRY W. BURNETT, M.D., Dayton, Ohio
HARRY HAUSER, M.D., Cleveland, Ohio
CARROLL C. DUNDON, M.D., Cleveland, Ohio
EVERETT L. PIRKEY, M.D., Louisville, Kentucky

PUBLICATION COMMITTEE
GEORGE L. SACKETT, M.D., *Chairman*, Cleveland, Ohio
HAROLD W. JACOX, M.D., New York, New York
LEO G. RIGLER, M.D., Minneapolis, Minnesota

PROGRAM COMMITTEE
JOHN D. CAMP, M.D., Rochester, Minnesota, retires in 1949
EARL R. MILLER, M.D., San Francisco, California, retires in 1950
BARTON R. YOUNG, M.D., Philadelphia, Pennsylvania, retires in 1951
President—EDGAR P. MCNAMEE, M.D., Cleveland, Ohio.
Secretary-Treasurer—DONALD S. CHILDS, M.D., Syracuse, New York
Scientific Exhibits Chairman—CLARENCE E. HUFFORD, M.D., Toledo, Ohio
Refresher Course Chairman—C. EDGAR VIRDEN, M.D., Kansas City, Missouri

RADIOLOGISTS-MANUFACTURERS COMMITTEE
MORETON J. THORPE, M.D., *Chairman*, Reno, Nevada, retires in 1949
ROBERT B. TAFT, M.D., Charleston, South Carolina, retires in 1950
RALPH G. WILLY, M.D., Des Plaines, Illinois, retires in 1951
CESARE GIANTURCO, M.D., Urbana, Illinois, retires in 1952
RICHARD CHAMBERLAIN, M.D., Philadelphia, Pennsylvania, retires in 1953

ADVISORY COMMITTEE ON X-RAY AND RADIUM PROTECTION
ROBERT S. STONE, M.D., *Chairman*, San Francisco, California
GIOACCHINO FAILLA, Sc.D., New York, New York

BY-LAWS AND RESOLUTIONS COMMITTEE
THOMAS B. BOND, M.D., *Chairman*, Fort Worth, Texas
PAUL C. SWENSON, M.D., Philadelphia, Pennsylvania
CALVIN L. STEWART, M.D., San Diego, California

BOARD OF CENSORS COMMITTEE
ALFRED L. LOOMIS BELL, *Chairman*, Brooklyn, New York, retires in 1949
L. HENRY GARLAND, M.D., San Francisco, California, retires in 1950
HAROLD E. NICHOLS, M.D., Seattle, Washington, retires in 1951
FREDERICK W. O'BRIEN, M.D., Boston, Massachusetts, retires in 1952
CHARLES HEACOCK, M.D., Memphis, Tennessee, retires in 1953

COMMERCIAL EXHIBITS COMMITTEE
THEODORE J. WACHOWSKI, M.D., *Chairman*, Wheaton, Illinois
J. CASH KING, M.D., Memphis, Tennessee
WALTER R. SCOTT, M.D., Niagara Falls, New York

INSURANCE COMMITTEE
DONALD R. LAING, M.D., *Chairman*, Pasadena, California
GERALD LAVNER, M.D., Haverhill, Massachusetts
MAURICE D. FRAZER, M.D., Lincoln, Nebraska

REFRESHER COURSE COMMITTEE
C. EDGAR VIRDEN, M.D., *Chairman*, Kansas City, Missouri
PAUL C. SWENSON, M.D., Philadelphia, Pennsylvania
KENNETH S. DAVIS, M.D., Los Angeles, California

REPRESENTATIVES OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA ON THE AMERICAN BOARD OF RADIOLOGY
L. HENRY GARLAND, M.D., San Francisco, California, retires in 1950
DONALD S. CHILDS, M.D., Syracuse, New York, retires in 1952
IRA H. LOCKWOOD, M.D., Kansas City, Missouri, retires in 1954

REPRESENTATIVE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA ON THE AMERICAN STANDARDS ASSOCIATION
FREDERICK O. COE, M.D., Washington, D. C.

REPRESENTATIVE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA ON THE BOARD OF CHANCELLORS OF THE AMERICAN COLLEGE OF RADIOLOGY
JOHN D. CAMP, M.D., Rochester, Minnesota, retires in June 1953

SCIENTIFIC EXHIBITS COMMITTEE
CLARENCE E. HUFFORD, M.D., *Chairman*, Toledo, Ohio
JAMES N. COLLINS, M.D., Indianapolis, Indiana
IVAN J. MILLER, M.D., San Francisco, California

TRUSTEES OF THE MEMORIAL FUND
President of The Radiological Society of North America, Inc.
Secretary of The Radiological Society of North America, Inc.
ROBERT S. STONE, M.D., San Francisco, California, retires in 1949
RAYMOND G. TAYLOR, M.D., Los Angeles, California, retires in 1951
W. WALTER WASSON, M.D., Denver, Colorado, retires in 1953

COUNSELORS FOR 1949

CANADA

Alberta	W. Herbert McGuffin, M.D., 224 Seventh Avenue, West	Calgary
British Columbia	Ethlyn Trapp, M.D., 925 West Georgia Street	Vancouver
Manitoba	Robert A. MacPherson, M.D., 118 Medical Arts Building	Winnipeg
New Brunswick	A. Stanley Kirkland, M.D., General Public Hospital	St. John
Ontario	William Gilmore, M.D., 11 Hamilton Street	Stratford
	Eugene H. Shannon, M.D., St. Michael's Hospital	Toronto
Quebec	Carlton B. Peirce, M.D., Royal Victoria Hospital	Montreal
Nova Scotia	Charles M. Jones, M.D., Halifax Infirmary	Halifax

CUBA

Cuba	Juan Manuel Viamonte, M.D., Calle J. Numero 410, Vedado	Havana

MEXICO

Mexico	Manuel F. Madrazo, M.D., Londres Num 13	Mexico City

UNITED STATES

Alabama	James A. Meadows, M.D., 201 Medical Arts Building	Birmingham
Arizona	Edward M. Hayden, M.D., 23 E. Ochoa Street	Tucson
Arkansas	William R. Brooksher, M.D., 601 First Nat'l. Bank Building	Fort Smith
California	Harold A. Hill, M.D., 450 Sutter Street	San Francisco
	Harold P. Tompkins, M.D., 658 S. Westlake Avenue	Los Angeles
Colorado	Paul R. Weeks, M.D., 1612 Tremont Place	Denver
Connecticut	Ellwood W. Godfrey, M.D., 1676 Boulevard	West Hartford
Delaware	Bartholomew M. Allen, M.D., 2311 West 17th Street	Wilmington
District of Columbia	Frederick O. Coe, M.D., 1835 Eye Street, N.W.	Washington
Florida	Gerard Raap, M.D., 908 Huntington Building	Miami
Georgia	William F. Jenkins, M.D., Columbus Hospital	Columbus
Idaho	Alfred M. Popma, M.D., 220 North First Street	Boise
Illinois	Earl E. Barth, M.D., 303 East Chicago Avenue	Chicago
	Frederick H. Decker, M.D., Methodist Hospital	Peoria
Indiana	Lester A. Smith, M.D., 238 Hume-Mansur Building	Indianapolis
Iowa	James V. Prouty, M.D., 326 Higley Building	Cedar Rapids
Kansas	Peter E. Hiebert, M.D., 807 Huron Building	Kansas City
Kentucky	Donnan B. Harding, M.D., 190 North Upper Street	Lexington
Louisiana	Lucien A. Fortier, M.D., 700 Audubon Building	New Orleans
Maine	Forrest B. Ames, M.D., 11 Graham Avenue	Bangor
Maryland	John Evans, M.D., 217 Medical Arts Building	Baltimore
Massachusetts	Hugh F. Hare, M.D., 605 Commonwealth Avenue	Boston
Michigan	James E. Lofstrom, M.D., 1420 St. Antoine Street	Detroit
Minnesota	Walter H. Ude, M.D., 802 Medical Arts Building	Minneapolis
Mississippi	William R. Bethea, M.D., 314 Standard Life Building	Jackson
Missouri	David S. Dann, M.D., 410 Professional Building	Kansas City
Montana	John H. Bridenbaugh, M.D., 208½ North Broadway	Billings
Nebraska	Howard B. Hunt, M.D., Nebraska M.E. Hospital	Omaha
Nevada	Moreton J. Thorpe, M.D., 17 North Virginia Street	Reno
New Hampshire	Leslie K. Sycamore, M.D., Mary Hitchcock Hospital	Hanover
New Jersey	Philip S. Avery, M.D., Woodland Terrace	Bound Brook
New Mexico	Charles M. Thompson, M.D., Box 72	Albuquerque
New York	Ross Golden, M.D., 622 West 168th Street	New York
	Edward C. Koenig, M.D., 100 High Street	Buffalo
North Carolina	J. Rush Shull, M.D., 323 Professional Building	Charlotte
North Dakota	Willard W. Wall, M.D., Box 935	Minot
Ohio	Harold G. Reineke, M.D., 927 Carew Tower	Cincinnati
	Harry Hauser, M.D., 3395 Scranton Road	Cleveland
Oklahoma	William E. Eastland, M.D., 705 Medical Arts Building	Oklahoma City
Oregon	Ivan M. Woolley, M.D., 242 Medical Arts Building	Portland
Pennsylvania	Peter B. Mulligan, M.D., South Hoffman Boulevard	Ashland
	Thomas P. Loughery, M.D., 5727 Wister Street	Philadelphia
	Harvey N. Mawhinney, M.D., 601 Jenkins Building	Pittsburgh
Rhode Island	Russell R. Hunt, M.D., 825 Chalkstone Avenue	Providence
South Carolina	Robert B. Taft, M.D., 105 Rutledge Avenue	Charleston
South Dakota	Ernest P. Brock, M.D., 802 St. Joe St.	Rapid City
Tennessee	J. Marsh Frere, M.D., 707 Walnut Street	Chattanooga
Texas	Thomas B. Bond, M.D., 815 Medical Arts Building	Fort Worth
	George Turner, M.D., 913 First National Bank Building	El Paso
	Palmer E. Wigby, M. D., 2043 Goldsmith	Houston
Utah	James P. Kerby, M.D., P.O. Box 447	Salt Lake City
Vermont	Benjamin F. Cook, M.D., Rutland Hospital	Rutland
Virginia	George Cooper, Jr., M.D., Box 1475, University Station	Charlottesville
Washington	Harold E. Nichols, M.D., Stimson Building	Seattle
West Virginia	Cole D. Genge, M.D., 722 First Huntington National Bank	Huntington
Wisconsin	Silvanus A. Morton, M.D., Columbia Hospital	Milwaukee
Wyoming	Walter R. Wynne, M.D., Wyoming National Bank Building	Casper

ARMY, NAVY AND VETERANS ADMINISTRATION

Army	James P. Cooney, Colonel, M.C., 9125 Eton Road	Silver Springs, Maryland
Navy	Robert S. Stimpson, Captain, M.C., U.S. Naval Hospital	Newport, Rhode Island
Veterans Administration	Aubrey O. Hampton, M.D., Garfield Hospital, 10th and Florida Avenue, N.W.	Washington, D. C.

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 52 APRIL 1949 No. 4

Arthrograms[1]

H. KELIKIAN, M.D., and ELBERT KENNETH LEWIS, M.D.

Chicago, Ill.

THE JOINT IS A connective-tissue organ. It connects and supports parts and in some instances permits motion between them. A joint which allows free movement is called a diarthrosis; it contains a cavity which is lined by the smooth inner surface of the synovial membrane and hyaline articular cartilages. A fibrous capsule braces the synovial lining of the joint and the articular ends of bones support the hyaline plates.

Joint motion depends upon the integrity of the articular cavity and the smoothness of its lining. Movement is compromised when the cavity is obliterated or effaced, when it is invaded by the products of inflammation and of wear and tear, when it is encroached upon by growths, when it is partially or completely filled by fibrous, osseous, and osteocartilaginous deposits, and when the surfaces which line it are rough and incongruous. Information as to the contour, the content, the capacity, and the communications of the articular cavity would not therefore be amiss.

But the joint cavity is merely a connective-tissue space. It exists only in a negative sense and cannot be visualized in ordinary roentgenograms. Of the structures which surround it, only the bones cast definite shadows on the x-ray film. Studies of the roentgenograms of the articular ends of bones will at times give an inkling as to the condition of the joint cavity and its lining. The knowledge thus gained is at best indirect. Examination of films taken after introduction of a contrast medium into the articular cavity will furnish more direct information.

AIR AS A CONTRAST MEDIUM

In studying x-ray films of compound joint injuries, one often sees shadows indicative of air outlining the articular cavity. After surgical exploration and closure of joints, a considerable quantity of air will often be locked in the articular cavity and cast a contrasting shadow in the roentgenogram. Whether such experiences led the earlier workers to employ oxygen as a contrast medium for arthrograms is difficult to ascertain. It came into use early in the present century as a diagnostic agent for visualizing confined cavities, including those of the joint. Injection of this gas required special syringes and cumbersome containers; the oxygen was forced into the joint from the anesthetist's tank under pressure, which resulted in overdistention of the capsule and caused pain. In the late twenties, radiopaque liquids came into vogue and, of these, iodized oil

[1] From the Department of Bone and Joint Surgery, Northwestern University Medical School, the Wesley Memorial and Cook County Hospitals; and the Department of Roentgenology of the St. Bernard's Hospital, Chicago. Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947. Received for publication in November 1948.

was found to be the least irritating to the joint lining. It was used extensively and with enthusiasm, but it was not long before its disadvantages as a contrast medium were discovered. For one thing, it cast too heavy a shadow, which blotted out even osseous markings. Then again the oil remained unabsorbed for a protracted period of time and made subsequent x-ray studies of the articular ends of the bones, as well as of the joint, useless. Out of the welter of experience with iodized oil in joints, only one observation appeared amenable to practical application: when introduced into inflamed joints, the oil rapidly passed out into the regional lymphatics, which could be seen impregnated in subsequent x-ray films; when introduced into old burnt-out joints, the oil remained unabsorbed for months and the x-ray failed to visualize regional lymph nodes. The rate of absorption of the iodized oil from the joint cavity was taken as an index of hyperemia and hence of inflammation of its synovial lining. As a practical application of this principle, whenever synovectomy is contemplated, a few cubic centimeters of iodized oil are introduced into the joint preoperatively and roentgenograms are obtained at weekly intervals. If the oil impregnates the regional lymph nodes during the first few weeks, surgery is postponed for fear of fanning a smoldering fire. If, on the other hand, the oil remains unabsorbed, or the regional lymph nodes fail to become impregnated after a month or more, it is supposed that the inflammation has cooled off and surgery is considered safe.

The lesson thus learned was a side issue —a by-product of the main problem of finding a diagnostic method which would yield more direct information about the articular cavity. Iodized oil failed to solve that problem. We kept on noticing shadows cast by the pent-up air in roentgenograms obtained soon after arthrotomy but felt fettered by the phraseology which linked the word "air" with infection and embolism. At last we made one break and decided to autoclave the air in withdrawn syringes and introduce their contents into the joint. But soon this method ran into several snags; the syringes came out from the sterilizer hot and in many instances the plunger stuck. The second step—that of injecting operating room air—had to be taken and we found ample justification in the fact that if, in the course of an arthrotomy, one allowed the surgically opened joint to bathe itself in gallons of room air, 100 c.c. of the same air introduced into the joint by a fine needle was not likely to hurt it. Since then, over a period of seventeen years, we have injected more than three thousand joints and have found ordinary room air both harmless and practical. At the time of surgery or at subsequent aspirations, numerous samples of joint fluid were submitted for bacterial examination, and in no instance were positive cultures obtained.

As a contrast medium air has several advantages: it is always available; it is more radiolucent than joint transudate or exudate, fat, muscle, or cartilage; it contrasts well with the articular capsule and accessory joint structures; it passes into and outlines all the compartments of the joint cavity; it seeps through the narrowest isthmus into the diverticula which may communicate with the joint cavity; it is rapidly absorbed; it is harmless. Joint infection has not followed air injection. Air embolism is another myth. This is not to say that infection or embolism may not follow introduction of air into the joint cavity, that joint injections are to be undertaken indiscriminately, and that the technic of inserting a needle into the joint should not be done carefully, with cleanly care. Apart from the possibility of infection or embolism, there is the more plausible danger of injuring the articular surfaces, when one inserts a needle into the joint. The hyaline articular cartilage when scraped does not heal promptly, if at all. The introduction of a needle into a joint presupposes at least an elementary knowledge of the anatomy and the landmarks of the joints, some "tissue touch," and dexterity.

INJECTION OF JOINTS

Prior to plunging a needle into the joint the overlying skin is shaved and washed copiously with soap and water. It is then swabbed with alcohol. The landmarks of the joint are palpated and a few cubic centimeters of novocain are injected in and around the spot selected for the insertion of the needle. In general the point chosen does not overlie major vessels and nerves; it is closest to the joint cavity and no bulky muscles intervene; the articular capsule on the side of injection is such that it could be put under stretch by flexion and extension, turns and twists of the segment distal to the joint, or by manipulative displacement of a sesamoid bone like the patella; finally the needle is inserted where it would least traumatize the articular cartilage, especially its weight-bearing surfaces.

The *knee* is the most commonly injected joint. The surgeon stands on the side of the recumbent patient, whose limb lies extended on the table. With one hand the operator pushes the patella outward, displacing it well laterally until the capsule spanning the outer border of the kneecap and the lateral femoral condyle becomes taut. A point is selected over the tense capsule on a level with the line which passes midway between the upper and lower poles of the patella, transversely. The spot chosen falls, roughly, below and to the outside of the insertion of the vastus lateralis into the patella. While the kneecap is still held displaced laterally, and the capsule remains tense, the overlying area is infiltrated with about 5 c.c. of novocain; a 22-gauge needle, 1 1/8 inch long (longer for the obese), is inserted in the wake of the local anesthetic and is slowly pushed through the taut joint capsule. Once it is in, the joint fluid is aspirated; if the tap is dry, the patella is moved from side to side to make certain that it rolls over the needle. About 100 c.c. of air is injected into the knee either with a plain syringe or with one connected to a three-way stopcock. When the suprapatellar pouch is well inflated and forms a boggy crescent around the patella, the needle is pulled out; the point of insertion into the skin is sealed with a small wick of sterile cotton, soaked in collodion.

On the whole, the injection of other joints follows the same pattern. In the lower limb, arthrograms of the *hip* yield the least information. This joint is buried deep in bulky muscles. The comparatively small amount of air which can be introduced into the joint can hardly be expected to cast contrasting shadows on x-ray films. Arthrograms obtained by the use of radiopaque solutions instead of air as a contrast medium are said to be of value in distinguishing congenital dislocations of the hip in children from subluxations. We confess our lack of experience in this field.

Next to the knee in the lower limb, the *ankle* lends itself best to arthrography. This is a superficial joint; it is almost subcutaneous. Except for the vestigial fibers of the peroneus tertius, no muscle crosses the ankle, and the bones which go into the formation of its socket can well be palpated. The articular cavity is accessible either in front of the fibular or of the tibial malleolus. The perforating branch of the peroneal artery and the terminal sensory twigs of the musculocutaneous nerve cross the area in front of the fibular malleolus whereas the corresponding area anterior to the tibial malleolus is comparatively avascular and is therefore better suited for the insertion of the needle. The foot is plantar-flexed until the tendon of the tibialis anterior muscle stands out. A horizontal line is drawn from the tip of the malleolus to the inner border of the anterior tibial tendon. This line is bisected and a centimeter-long perpendicular is raised from the mid point. The tip of the vertical line serves as the spot for the insertion of the needle. With the foot still plantar-flexed, the needle is guided backward medially and slightly upward through the anterior capsule. The ankle joint will take about 10 to 15 c.c. of air.

In the upper extremity, the *acromioclavicular joint* is the most accessible. The plane of the articular surface of the outer

clavicle is beveled: the articular facet it bears tilts from above downward and medially; it faces downward and laterally. The articular rim of the outer clavicle is palpated; the needle is inserted just outside its superior articular border, and is directed downward and medially. The acromioclavicular joint will take about 2 c.c. of air.

Arthrography could be most useful in diagnosis of tears of the musculotendinous cuff of the *shoulder*, but here again one meets with the same difficulty in seeing the shadow cast by air in the joint as in the case of the hip. The shoulder, too, is well swathed in muscles, though to a much lesser extent than the hip. When these muscles are thin, as in women and elderly men, the air in the articular cavity may cast a contrasting shadow. The coracoid process is palpated and the arm is externally rotated to put the subscapularis tendon and the capsule beneath it under stretch. The needle is inserted just lateral to the tip of the coracoid process. It is directed downward and backward. The shoulder will take about 50 c.c. of air.

In the upper limb, the *elbow* lends itself best to arthrography. The forearm is placed at a right angle to the arm and in mid position as to pronation and supination. An imaginary line is drawn from the lateral epicondyle to the olecranon tip and the needle is inserted about midway between these two points; it is pushed downward and forward toward the radial head, which can be palpated by pressing the thumb just below the lateral epicondyle while the patient slowly pronates and supinates his forearm. The elbow will take about 30 c.c. of air.

Only rarely are arthrograms of the *wrist* indicated. The hand is flexed at the wrist; the overhanging dorsal rim of the distal articular end of the radius is palpated in line with the second metacarpal bone. The needle is inserted just below the radial ridge and is directed volarward and proximally, parallel to the distal articular surface of the radius, which inclines about 15 degrees forward. The radiocarpal articulation is snug; it will take only about 3 c.c. of air.

RADIOGRAPHIC TECHNIC

Arthrography is a special procedure. It requires different methods of exposure. It is important that roentgenograms be taken soon after the introduction of air into the joint cavity. As movement and activity disperse air out of the joint cavity, the patient must not ambulate in the interim.

Maximum detail on the x-ray film is desirable. Small focal-spot x-ray tubes should be used; exposure time must be short, and the limb should be immobilized by sandbags or similar contrivance to prevent motion. Proper centering of the rays through the articular space is essential to avoid superimposition of bone shadows on soft-tissue structures. In the case of the knee, this can be done by palpating for the femoral and tibial condyles and using these as landmarks. Since the air is rapidly absorbed, it is best to look at the wet films before discharging the patient. Additional views may be required so as to throw suggestive shadows into greater relief.

There are several basic principles which require special emphasis:

(1) *Air mounts to the top:* Whenever it is desired to visualize certain compartments of the joint, as for instance the suprapatellar pouch of the knee, films must be taken with the patient upright; conversely, when one desires to visualize the popliteal chambers, the patient must lie face down.

(2) *Air is compressible:* The suprapatellar pouch of the knee is best visualized with the limb in extension, as in the standing position. When it is desired to visualize the posterior compartments of the knee, not only must the patient be prone, but he must also flex the leg to about 45 degrees so as to relax the gastrocnemii, which, when under tension, will compress the posterior capsule against the femoral condyle and obliterate the space between them. More air may be pushed into these

tighter posterior chambers of the knee by applying a pressure bandage over such compressible compartments as the suprapatellar pouch.

(3) *Positioning of the limb* which might better evince details of contour, capacity, content, and communication of the joint necessitates five routine positions:

(*a*) Taking the knee as an example, anteroposterior projection is made with the patient in dorsal decubitus. The knee is flexed about 5 degrees. The central ray is projected perpendicularly to the long axis of the limb and centered through the articular space. This position shows the suprapatellar pouch, the outlines of the hyaline cartilage covering the femoral condyles, the inner and superior margins of the menisci, and to some extent the dorsal pouches.

(*b*) The postero-anterior study is made with the patient in a kneeling position, with the knee flexed about 35 degrees. The central ray is projected so as to bisect the angle of the flexed joint and centered through the articular space. This view visualizes the cruciate ligaments, the menisci, the hyaline cartilage, the tibial spines, and the intercondylar notch of the femur.

(*c*) The lateral decubitus view is obtained with the patient lying on the affected side. The knee is flexed 45 degrees. The central ray is projected perpendicularly to the long axis of the tibia. The radiograph obtained shows the contour, capacity, and content of the suprapatellar pouch, its septum, the hyaline cartilage covering the articular surfaces of the patella and femoral condyles, the lateral meniscus, the infrapatellar fat pad, the contour of the anterior compartment of the knee, and sometimes the ligamentum mucosum, the dorsal pouches, and the diverticula communicating with them.

(*d*) A lateral view with the patient lying on the back is obtained with the knee extended. The x-ray tube is turned so that the central ray is parallel to the table top and centered through the articular space. The position described compresses the air into the suprapatellar pouch, distends it, and demonstrates its contour and capacity. The projection is also advantageous in showing a fluid level, communication to the prepatellar bursa, location and freedom of osteocartilaginous loose bodies.

(*e*) The lateral projection with the patient prone is made with the knee partly flexed, while the central ray is directed horizontally, parallel to the table top, and through the articular space. This position is a most valuable adjunct in demonstrating the dorsal compartments of the knee; also in visualizing a gastrocnemio-semimembranosus outpouching, or Baker's cyst, and diverticulum along the popliteus. In this view it is important to compress the air from the suprapatellar pouch downward to the patella. The air will distend the dorsal pouches, best outlining their contour, capacity, content, and communications.

(4) *Additional views* are sometimes needed to visualize better a portion of the joint or its contents.

(*a*) A tangential position or "sky-view" of the articular surfaces of the patella is taken with the patient lying supine and his knee bent about 60 degrees. The radiograph will show the contents of this portion of the joint cavity, bipartite patella, fracture or dislocation of the patella; it localizes the posterior outpouching of Baker's cyst to the medial side of the knee.

(*b*) The "upright or standing" anterior and lateral views of the knee are made with the x-ray tube in the horizontal position. These views are helpful in showing single and multiple fluid levels, freedom of metallic or osseous bodies in the articular cavity.

(*c*) The oblique views are made with the patient prone, when trouble is suspected in the anterior compartment or suprapatellar pouch; conversely, with the patient lying on the back when the area of interest is posterior. These positions are valuable in proving an interarticular loose body, separation of a dead fragment in osteochondritis dissecans, and avulsion of the tibial spine, in injury to the posterior cruciate ligament and lateral meniscus.

(*d*) Anteroposterior views with the patient on the side may be taken with the tube parallel to the table top. The affected side of the knee is placed uppermost so that the air may collect at the site under suspicion. These views are more useful than routine ones when it is desired to show an injury to a meniscus. Spreading the knee joint is important. This may be done by placing the knee over a balsa block and exerting pressure over the thigh and leg during the x-ray exposure. Compression of air from the suprapatellar pouch into the knee is a helpful adjunct in these views.

(5) *A correct exposure technic is important:* The quality of x-rays to be used is that for soft-tissue exposure rather than for bone. Kilovoltage is reduced slightly below the amount routinely used. Overpenetration is avoided. The kilovoltage factor is selected by measurement of thickness of the part in centimeters. The opposite knee may be used for this measurement. Good contrast is obtained with lower-kilovoltage and high-milliamperage-seconds technic. A short exposure time is desirable, preferably one-half second or less. Using a rotating anode tube, we have found the following technical factors satisfactory for anteroposterior views of the average knee: kilovoltage 56, milliamperage 100, time one-twentieth second, focal-film distance 40 inches. In the lateral position the kilovoltage may be reduced by 2 kv., other factors remaining the same.

ANATOMY OF THE KNEE AS REVEALED IN ARTHROGRAMS

Interpretation of shadows cast in arthrograms is based upon an understanding of the structures contained in the joint cavity and those which surround it. The tissues which are related to the articular cavity offer different degrees of resistance to roentgen rays and cast shadows of varying density in arthrograms. The articular ends of bones cast denser shadows than do blood, joint fluid, hyaline articular cartilage, fibrous and synovial capsule, ligaments, intra-articular fibrocartilage, muscles, and tendons which may cross or contact the joint. All these tissues are less radiolucent than fat. Air is more radiolucent than fat, and its shadow will contrast well with those representing both skeletal and soft-tissue elements. Allocation of various shadows seen on arthrograms must necessarily depend upon an understanding of the anatomy of the structures they are thought to represent and of the relation each structure bears toward the articular cavity.

The knee is subjected to arthrography far more frequently than any other joint. It is a complex articulation: it contains intra-articular fibrocartilages and ligaments; the articular cavity is lined by the most extensive investment of synovial membrane and hyaline plates. Besides the vast coat of cartilage which covers the articular ends of the femur and the tibia, the joint cavity receives additional lining from the articular facet of the largest sesamoid bone in the body, the patella. The fabella, a small sesamoid bone often found in the lateral head of the gastrocnemius, also offers the articular cavity of the knee a hyaline surface.

The knee is a weight-bearing joint. It links the longest two bones in the skeleton —two long levers which can be pried and twisted. The joint gains no strength or security from the adaptive configuration of the bones it unites. Unlike the ankle, the knee has no side buttresses such as the malleoli; it has no protective hood like the shoulder; it has no ball-and-socket arrangement such as is present in the hip; no massive muscles swathe or support it. The knee is a superficial articulation; it is weak and vulnerable, heir to a multitude of derangements which offer diagnostic problems. It is by understanding what constitutes normal that the abnormal can be recognized. The articular cavity of the knee, which concerns us most in studying arthrograms, has a large cul-de-sac above the patella, an extensive anterior chamber, and two rear compartments.

The *suprapatellar pouch* is a large pocket which extends above the patella. It lies between the quadriceps tendons in front

and the distal shaft of the femur behind. Between it and the femur there is a large cushion of fat. The ascent of the suprapatellar pouch, up toward the thigh, is variable: the pouch is large and mounts higher where it has been subjected to chronic effusion and has become distended by excessive fluid; for reasons unexplained, it is small in some subjects with fibrous dysplasia of the distal shaft of the femur. A fold of synovial membrane, the suprapatellar plica, often intercepts the pouch and in lateral arthrograms is seen as a band-like filling defect suggestive of a septum. Occasionally a veritable septum divides the suprapatellar pouch into two distinct sacs, one above and one below. The aperture in the septal plica may be so small as to permit the passage of air and transudate, but not solid particles, from one synovial pouch to the other. Rarely the septum is imperforate. The suprapatellar pouch and the fat pad between it and the femur are best visualized in lateral arthrograms.

The *anterior chamber* of the knee lies behind the patella, in front of the condyles of the femur, and above the greater anterior half of the bearing surface of the tibia. Its walls are therefore lined partly by synovial membrane and in part by hyaline plates. From around the articular border of the patella, the synovial membrane fans out sideways; it sweeps backward to form two side pockets on either side of the patella and is then reflected over the nonarticular portions of the condyles of the femur. In arthrograms the parapatellar pockets are best visualized in the sky-view exposure of the patella.

From the inferior border of the patella, the synovial membrane passes down over a large cushion of fat that lies behind and on the sides of the patellar tendon. The infrapatellar fat pad, which really constitutes the outer supportive layer of the synovial lining, fills the interspace below the patella, between the femoral condyles and the tubercles of the tibia. On either side of the central pad of fat, the synovial membrane forms two side folds, the alar ligaments; from the center of the fat pad a tube of synovial membrane, the ligamentum mucosum, tapers backward toward the intercondylar notch of the femur; there the ligamentum mucosum blends with the synovial investment of the cruciate ligaments. In lateral arthrograms, the infrapatellar fat pad is revealed as a truncated wedge with a tongue extending backward. There may be shadows indicative of calcific deposits at the tip of the tongue.

Below the alar folds, the synovial membrane of the anterior chamber is reflected part way over the upper surface of the circumferential border of the menisci, leaving their inner lips uncovered; the under surface of the circumferential border of each semilunar cartilage is also invested part way by the synovial membrane. The latter sweeps peripherally and lines the small pouch underneath the outer border of the semilunar cartilage and the periphery of the corresponding tibial tubercle. These so-called coronary pouches underneath the menisci are sometimes visualized in anteroposterior arthrograms; the semilunar cartilages are represented by pyramidal shadows on either side of the knee between the femoral condyles and the respective tubercles of the tibia. The base of the meniscal pyramid, or wedge, is directed outward, while its apex points toward the middle of the knee.

The *two rear compartments of the knee*, which lie behind the femoral condyles, are separated by a septum early in life. Occasionally the septum remains inperforate, but usually it bears a fenestrum at its proximal pole. The communication between the posteromedial and posterolateral compartments of the knee more often extends through the anterior chamber, where all that remains of the intercondyloid septum is the vestigial ligamentum mucosum. The synovial envelope of the septum separating the two rear compartments of the knee contains the cruciate ligaments, the middle geniculate artery, and the ligament of Humphrey or Wrisberg, which binds the rear horn of the

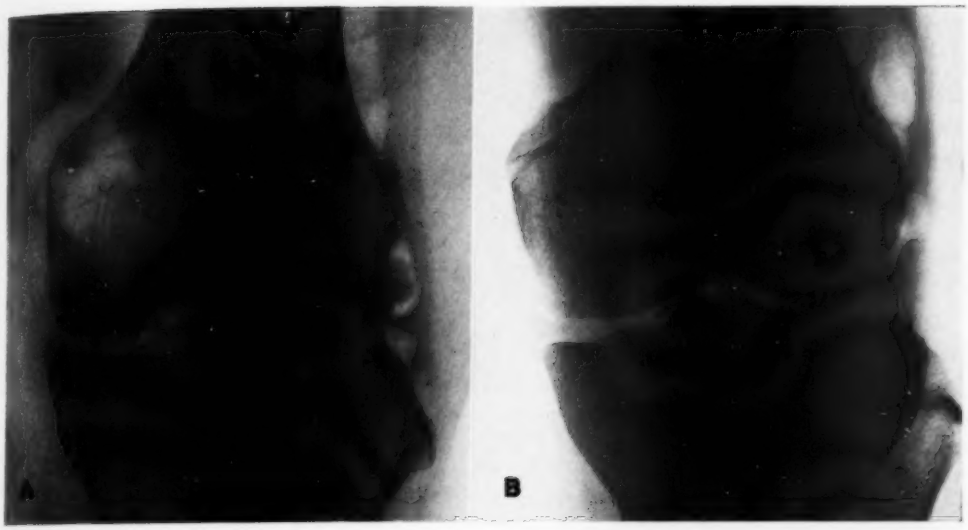
lateral meniscus to the posterior cruciate ligament. In intercondyloid arthrograms, the cruciate ligaments, which are extrasynovial but intra-articular, are revealed as two dense ribbons. The disposition of the two cruciates can be simulated by crossing the long finger of one's homolateral hand astride the index in front of the knee: parallel to the long finger, the anterior cruciate descends from the medial surface of the lateral condyle of the femur down and forward to the inner half of the fossa in front of the spine of the tibia. Like the index finger, the posterior cruciate passes from the lateral surface of the medial condyle of the femur, down and backward to the area behind the spine of the tibia.

The synovial investment of the septum separating the two rear compartments of the knee sweeps to the articular border of the respective condyles of the femur. From the rim of these facets, the synovial membrane curls backward to line the anterior surface of the posterior capsule of the knee. It then passes part way over the posterior horns of the semilunar cartilages. As in front of the joint, there is also a coronary pouch beneath the posterior horns of the semilunar cartilages. Of the two compartments, the posteromedial is the larger; as the lateral femoral condyle is prominent anteriorly, the medial condyle is prominent posteriorly and needs more room. From the posteromedial compartment of the knee, a diverticulum often extends down under the medial head of the gastrocnemius and curls up and around the tendon of the semimembranosus. From the posterolateral compartment, a narrow synovial pocket descends down along the popliteus tendon and often connects with the proximal tibiofibular joint. Both posterior compartments of the knee and the diverticula which connect with them are best visualized in lateral arthrograms. The distinction between the two outpouchings is based on the size and configuration of the shadow they cast when filled with air. The gastrocnemio-semimembranosus bursa is large, loculated, or tortuous; it curls down and then up and backward. The diverticulum along the popliteus is narrow; it curves backward and downward.

EVALUATION OF ARTHROGRAMS

The study of arthrograms has enriched our knowledge of joint anatomy and pathology. It has helped the surgeon to plan better preoperatively. When, for instance, a piece of metal or an osteocartilaginous loose body is visualized in one compartment of the articular cavity, or in a diverticulum, the incision is appropriately placed and extended. As a diagnostic aid, arthrography should be utilized to supplement other measures; the data culled must be correlated with understanding of the morphology and the morbid anatomy of the structure under scrutiny.

Lesions of the Semilunar Cartilages of the Knee (Figs. 1 and 2): (1) The medial meniscus of the knee forms the segment of a larger circle; it is more oval than circular; its horns diverge, giving the cartilage an elongated span. The lateral meniscus is more circular; its anteroposterior diameter is small and its horns converge. (2) All along its circumferential border, the medial semilunar cartilage is firmly connected to the tibial collateral ligament; in addition, it receives attachment from the semimembranosus tendon. The fibular collateral ligament of the knee by-passes the lateral semilunar cartilage and the popliteus muscle, which occupies a position analogous to that of the semimembranosus, rubs but does not connect with the circumferential border of the lateral meniscus. A fold of synovial membrane intervenes between the meniscus and the popliteus tendon; from this plica a diverticulum extends down along the popliteus tendon and an isthmus at times connects this outpouching with the proximal tibiofibular joint. In back of the knee the lateral semilunar cartilage sends a strong fibrous slip to the posterior cruciate ligament. (3) The articular facet of the tibia, which the medial meniscus deepens, is definitely concave; it is cupped from before backward, and the semilunar cartilage rises



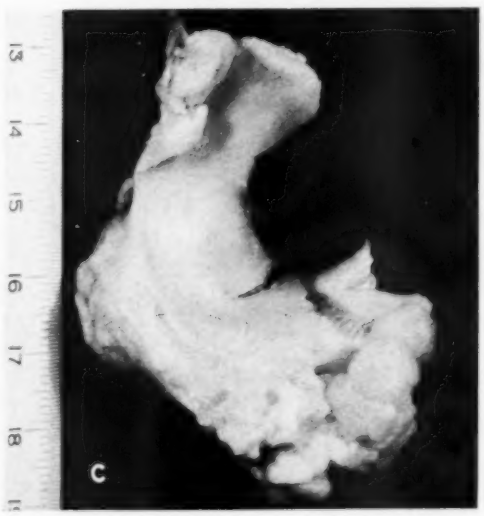
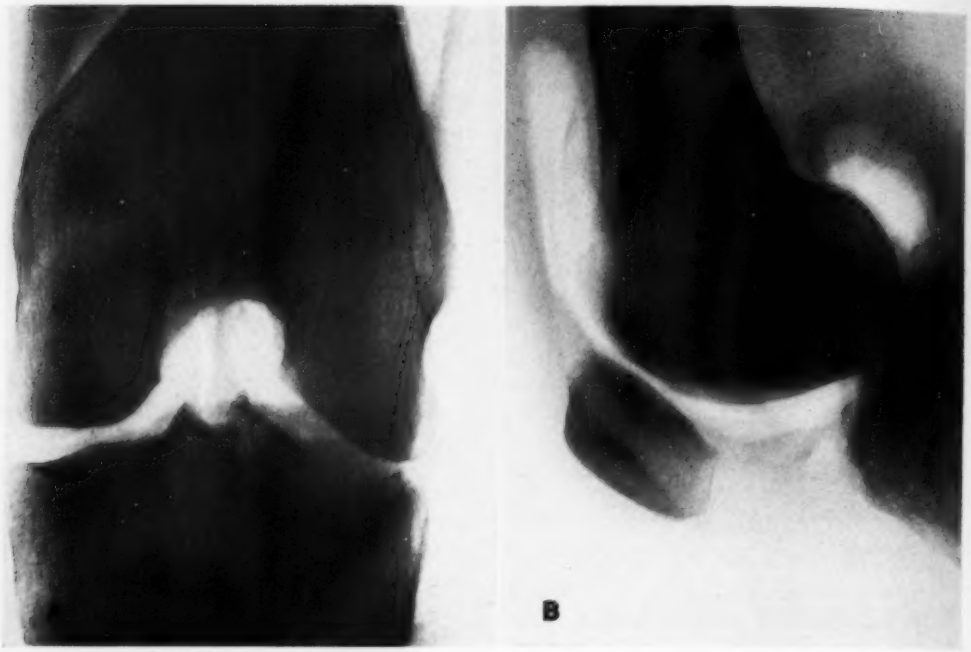


Fig. 1. Cysts of the semilunar cartilage.
A. Anteroposterior arthrogram of knee showing a polypoid tumor above the wedge-like shadow cast by the lateral meniscus. Note the air above and below the filling defect created by the polyp.
B. Anteroposterior arthrogram showing that the air space above the lateral meniscus is encroached upon and the wedge-like shadow normally cast by the lateral semilunar cartilage bulges superiorly.
C. Lateral meniscus removed from the knee illustrated in B, showing multiple synovial cysts at the periphery of the cartilage. These bulged into the joint along the superior margin of the semilunar cartilage.

from the central depression as a hedge. The outer articular facet of the tibia, which the lateral meniscus rims, is only slightly concave from side to side and is convex from before backward; its central unpadded area is small and lies flush with the superior surface of the lateral meniscus. (4) To compensate for the obliquity of the shaft above, the medial condyle of the femur tilts inward and is more prominent posteriorly: it has to be "screwed home" in the terminal phase of extension of the knee. This internal rotation of the femur or, what amounts to the same, external rotation of the tibia, is a common accompaniment not only of walking and standing but also of running, jumping, of throwing a ball or hitting it. External rotation of the femur, which would cause the lateral condyle to bear upon the meniscus underneath, is a comparatively uncommon movement.

Because it has less room to move, because it is more firmly connected and cannot move, because it hedges itself in the pathway of the grinding medial condyle of the femur and may be swept or stripped by it, and because this very internal rotation of the femur is a common activity, the medial semilunar cartilage is torn far more frequently than the lateral. The meniscus splits lengthwise, its circumferential border remaining attached to the tibial collateral ligament while the torn inner slip shifts toward the intercondyloid notch. The femoral condyle contacts the tibial



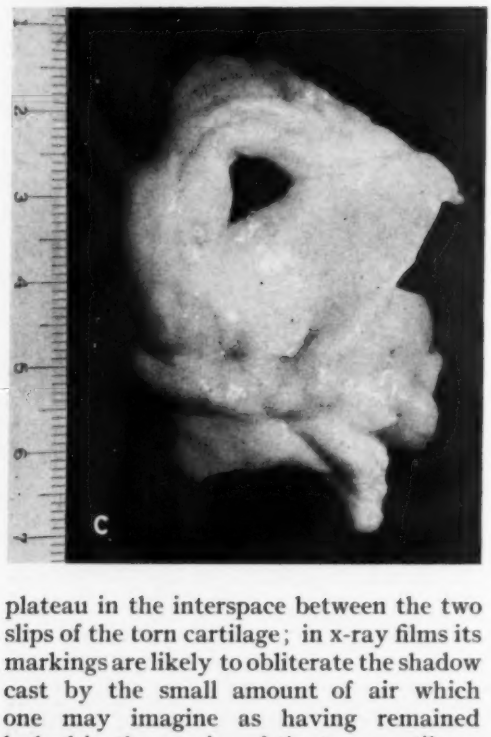


Fig. 2. Discoid and doughnut meniscus. Discoid cartilage is found on the lateral aspect of the knee. It may be in the form of a solid plaque or a doughnut. Its main characteristic is its firm attachment to the posterior cruciate ligament and through the latter to the femur, with which it moves rather than with the tibia.

A. Anteroposterior arthrogram showing a horizontal line which traverses the lateral femoral condyle.

B. Lateral view of the same. Note the elliptical density which extends beyond the lateral femoral condyle. The medial femoral condyle is more prominent posteriorly and its shadow overlaps that representing the lifted posterior half of the discoid cartilage.

C. Photograph of the perforated, doughnut-shaped, discoid cartilage removed from the same knee.

plateau in the interspace between the two slips of the torn cartilage; in x-ray films its markings are likely to obliterate the shadow cast by the small amount of air which one may imagine as having remained locked in the crevice of the torn cartilage.

Moreover, in the posteromedial aspect of the knee there is often a pouch: the gastrocnemio-semimembranosus bursa, which communicates with the knee and, when filled with air, casts its own shadow in anteroposterior arthrograms. Shadows cast by air around the medial meniscus of the knee are deceptive. The writers studied a series of 84 cases, trying to correlate such shadows with the findings at arthrotomy. There was an appalling discrepancy. It is true that in anteroposterior and postero-anterior arthrograms one can visualize the triangular wedge which the semilunar cartilage forms between the

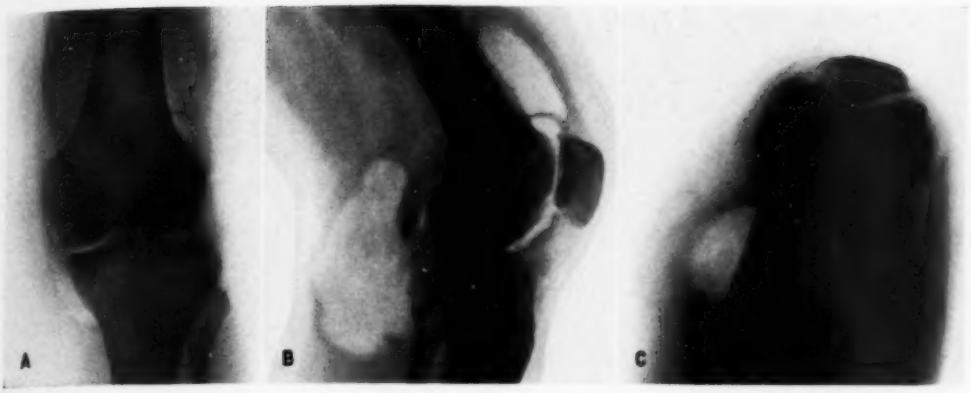


Fig. 3. Baker's cyst. Gastrocnemio-semimembranosus bursa is an extremely common diverticulum which connects with the posteromedial compartment of the knee. It partakes in all the reactions of the knee and distends when the joint is filled with fluid. At times, because of its dependent position and twisted course around the origin of the medial head of the gastrocnemius and the insertion of the semimembranosus tendon, it becomes the seat of inflammation. When large, it causes fullness behind the knee and interferes with flexion. Occasionally it contains osteocartilaginous loose bodies.

A. Anteroposterior arthrogram of the knee showing a large air-filled gastrocnemio-semimembranosus bursa on the medial side. B. Lateral view of the same. C. "Sky view" of the same. Note the air-filled bursa on the medial aspect of the flexed knee.

medial femoral condyle and the corresponding facet of the tibia, and that, at the extreme periphery of the joint, bursa and "coronary" pouches do not cast air shadows: if one saw shadows indicative of air form a pocket between the tibial collateral ligament and the shifting wedge of the semilunar cartilage, one might surmise a marginal tear of the medial meniscus. Such tears are more often seen in published diagrams.

Because it is confined and compact, and has more room to move, because it is unattached along its periphery and can yield to push or pull, because it lies flush with the uncovered portion of the superior articular surface of the tibia, and because it is not in the pathway of a more common twist of the femur, the lateral meniscus of the knee seldom tears. When the posterior cruciate to which it is attached in the back is avulsed, the lateral meniscus loosens its mooring in the rear and shifts forward into the knee. The attachment of the lateral semilunar cartilage by way of the ligament of Humphrey or Wrisberg to the posterior cruciate is reminiscent of early mammals, in which this cartilage is connected to the femur rather than the tibia and moves with the former. In man, the lateral meniscus has a greater tendency to atavism: it remains discoid, the most important feature of which is not the fact that the cartilage constitutes a solid plaque or an all-around circle, but that it is more firmly attached to the femur posteriorly and lifts from the tibia with a "clunk" when the posterior cruciate is made taut as in extension of the knee. Finally, the lateral meniscus is prone to cyst development along its circumferential margin, and the friction caused by the popliteus tendon may have something to do with these ganglia-like tumors. A loosened lateral meniscus in connection with tears of the posterior cruciate, discoid cartilage, and synovial cysts along its circumferential border can all be visualized in arthrograms (Figs. 1 and 2).

Synovial Outpouchings (*Fig. 3*): In the back of the knee a septum divides the articular cavity into two compartments. The so-called Baker's cyst or the gastrocnemio-semimembranosus bursa communicates with the inner and the diverticulum along the popliteus muscle connects with the outer compartment of the posterior knee joint. Both outpouchings partake in the changes to which the synovial lining of the main joint is heir: they contain

Fig. 4. Osteocartilaginous loose body in the gastrocnemio-semimembranosus bursa, which had been variously taken for phlebolith or fabella.

A. Lateral view x-ray film showing a coarsely trabeculated density in the popliteal region. Note that the density overlies the bulge of the gastrocnemius. Hence the suggestion that it might be a fabella.

B. The same in "sky view." Note that the density is medial along the course of the greater saphenous vein. Hence diagnosis of phlebolith.

C. Lateral arthrogram of the same. Air introduced under the patella in front fills the gastrocnemio-semimembranosus bursa in the rear and surrounds the coarsely trabeculated loose body.

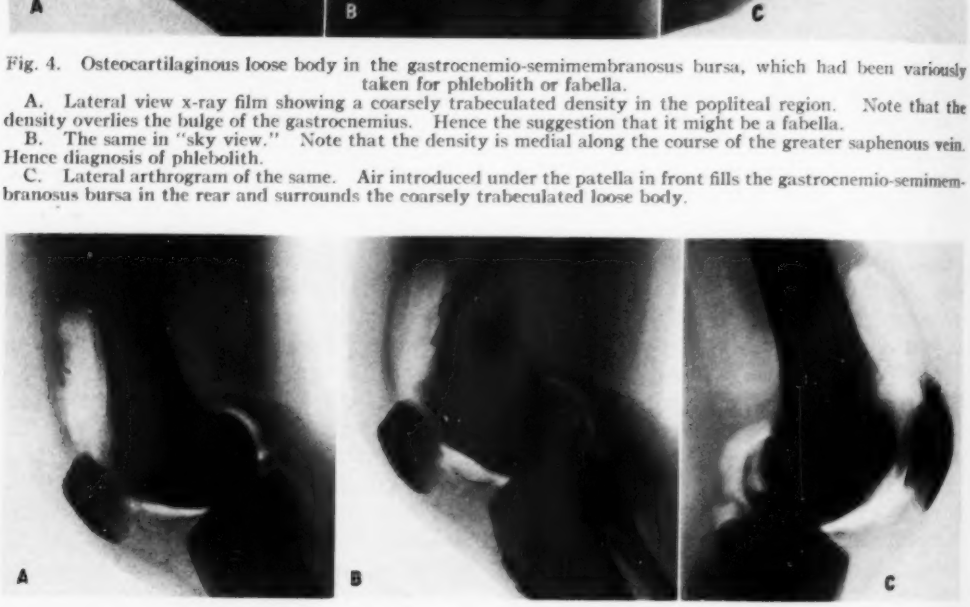


Fig. 5. Osteocartilaginous bodies around the suprapatellar pouch.

A. Lateral arthrogram showing mural osteocartilaginous bodies. Note that these bodies have pushed the synovial lining ahead of them, causing a rectangular filling defect in the suprapatellar pouch.

B. Lateral arthrogram showing a similar filling defect in the posterior wall of the suprapatellar pouch caused by calcification of the prefemoral fat pad.

C. Lateral arthrogram showing trabeculated densities proximal to the patella along insertion of the quadriceps. It is possible that these were caused by avulsion. At surgery they were found to be intratendinous, extrasynovial.

villi, adhesions, osteocartilaginous bodies, and gain in capacity with the rest of the joint cavity as a result of repeated hydrarthrosis. Their dependent position, their twisted course around tendons and muscles, and the narrow neck which joins them with the main articular cavity, subject these diverticula to localized irritations. They become filled and distended with thick glairy exudate which will not empty into the main joint and causes them to become distended and large and interfere with the flexion of the knee. The synovial lining of the popliteal outpouchings of the knee may form villi and osteocartilaginous bodies. Loose bodies formed in the main joint may gravitate into the popliteal diverticulum, usually into the one along the popliteus tendon, which connects with the joint through a wider neck. The

isthmus between the gastrocnemio-semimembranosus bursa and the inner compartment of the posterior knee is often too narrow to permit the passage of anything but transudate and air. One must therefore expect greater stagnation and enlargement of the gastrocnemio-semimembranosus outpouching. Osteocartilaginous bodies find their way more commonly into the diverticulum along the popliteus and through it into the proximal tibiofibular articulation. Arthrograms will reveal the size of these outpouchings, their content, and their connection with the main joint cavity.

Osteocartilaginous Bodies (*Figs. 4–12*): The synovial membrane which arises from the same primitive connective tissue but remains comparatively undifferentiated—hence reactive and reproductive—can produce both cartilage and bone by metaplasia. Named erroneously a membrane, the synovial investment of the joint consists of a flattened connective-tissue surface and an underlying vascular, adipose areolar or fibrous layer with no basement septum intervening. Most of the reactive and reproductive changes of the synovial membrane occur underneath its surface, within the outer vascular stratum. Here plaques of cartilage or bone may form and remain intramural; they may push their way into the joint and hang pedunculated or break loose into the articular cavity. Articular ends of bones themselves may give rise to osteocartilaginous loose bodies. In osteoarthritis, marginal or epiarticular osteophytes may become detached; pieces of bone covered with cartilage on one side may break loose into the joint following acute trauma; the articular end of a bone may become infarcted in part or in its entirety, due to blockage of the blood supply. Dead bone and cartilage crumble into pieces which float loose in the articular cavity. Arthrograms help to determine the number, the location, and sometimes the source of osteocartilaginous bodies in and around joints. It is always advisable to examine the opposite joint, as the con-

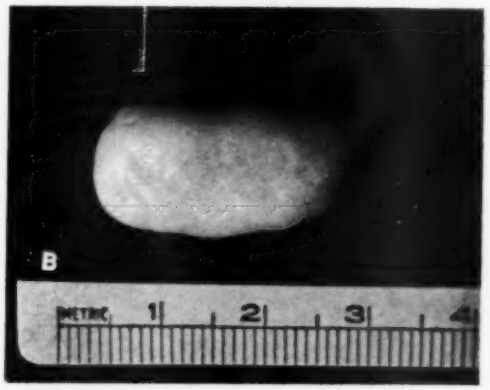


Fig. 6. Osteocartilaginous loose body incarcerated in the synovial tube along the popliteus tendon leading into the proximal tibiofibular joint. On arthrotomy of the posterior compartment, the loose body was not seen; it was palpated but could not be expressed until the narrow isthmus leading into the tibiofibular joint was slit open. Note in the pneumogram the extra-articular fabella. Compare the fine texture of the sesamoid bone with the coarse trabeculation of the loose body.

A. Lateral arthrogram showing an elongated oval osteocartilaginous body in the tube of air connecting the posterolateral compartment of the knee with the proximal tibiofibular joint.

B. Photograph of the extracted osteocartilaginous loose body. (From Kelikian: Surg. Clin. North America **27:** 157–181, February 1947.)

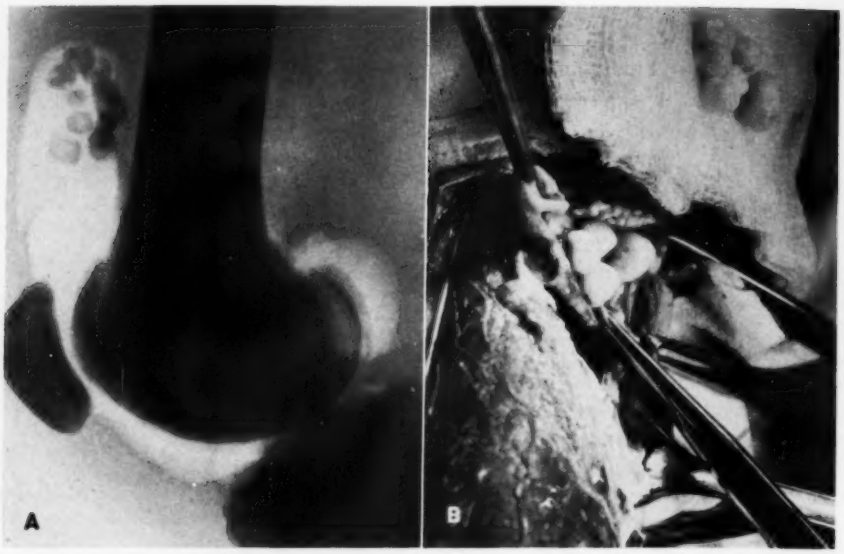


Fig. 7. Osteocartilaginous loose bodies suspended in the suprapatellar pouch.
A. Lateral arthrogram showing multiple osteocartilaginous bodies in the suprapatellar pouch above the plica. Air introduced under the patella has passed up and surrounded the loose bodies. It is presumed that these osteocartilaginous bodies were all of synovial origin, as the aperture in the septum was found to be pin-point at surgery and the lining of the sac revealed nests of chondroplastic metaplasia.
B. Photograph made at the time of arthrotomy, showing the extracted osteocartilaginous loose bodies and chondrofied synovial membrane.

Fig. 8. Osteocartilaginous loose bodies in the parapatellar pocket confused with Pellegrini-Stieda's disease.
A. Anteroposterior arthrogram of the knee in Pellegrini-Stieda's disease. Note that the calcific plate on the medial aspect is extra-articular. Air does not even touch it. This is a true Pellegrini-Stieda's disease.
B. Anteroposterior roentgenogram of the knee showing a trabeculated plaque along the lateral femoral condyle.
C. Arthrogram of the same. Note that air completely surrounds the elongated plaque, indicating that it is an osteocartilaginous loose body.

dition is at times bilateral. Occasionally one will find several members of the same family afflicted with a tendency toward formation of osteocartilaginous bodies in one or both knees.

Foreign bodies, such as shrapnel, present in the soft tissues close to a joint must also be localized. Arthrograms will reveal whether they are intrasynovial or extrasynovial (Fig. 13).

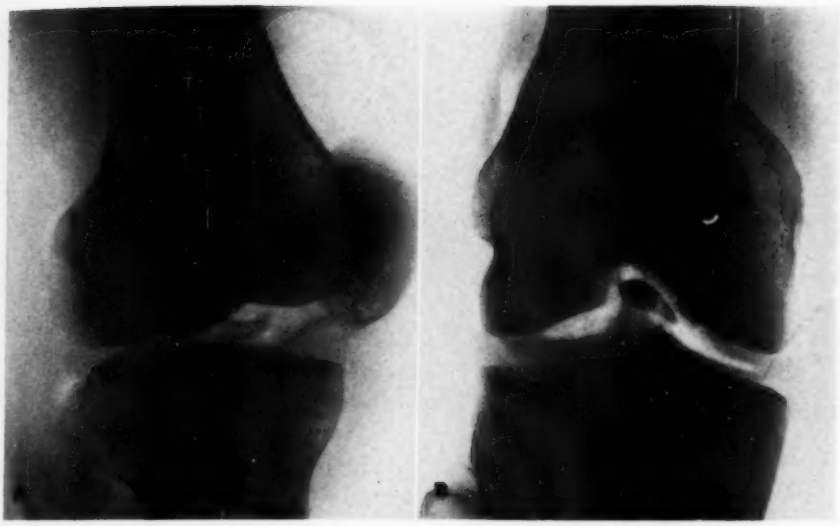


Fig. 9. Osteocartilaginous bodies in the intercondyloid notch.
A. Oblique view arthrogram showing a large piece of avulsed bone from the anterior spine of the tibia. Note that it is partially surrounded by air and has the same trabeculation as the tibia below. Avulsed bone has fine lacy trabeculation.
B. Intercondyloid view arthrogram showing an elliptical loose body probably the result of osteochrondritis dissecans. Note that it is completely surrounded by air and coarsely trabeculated. Infarcted bone has coarser trabeculae than avulsed ossicle.

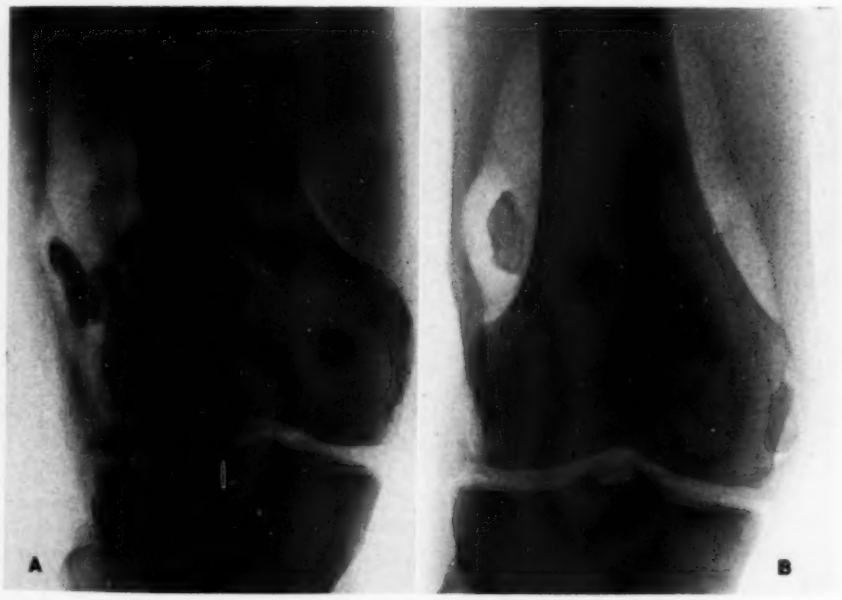


Fig. 10. Multiple, familial, bilateral osteocartilaginous loose bodies.
A. Anteroposterior arthrogram of one knee of a man with multiple osteocartilaginous loose bodies in both knees. His brother and father were similarly affected. B. Anteroposterior arthrogram of the opposite knee of the same patient.

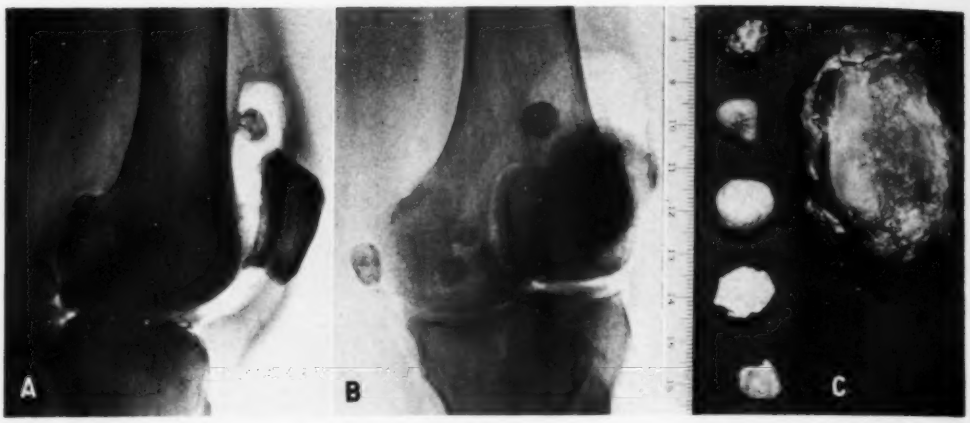


Fig. 11. Osteocartilaginous loose bodies arising from osteoarthritis of the knee, with mushroomed, malacic patella.

A. Lateral arthrogram showing multiple coarsely trabeculated osteocartilaginous loose bodies. Such bodies may secondarily attach themselves to the synovial membrane. However, the connection seen in the suprapatellar pouch is deceptive, as was proved at arthrotomy.

B. Oblique view of the same knee.

C. Photograph of the specimen. The patella was removed, since it was regarded to be the main source of the detached osteophytes. Note one large piece ready to separate from the margin of the mushroomed patella.

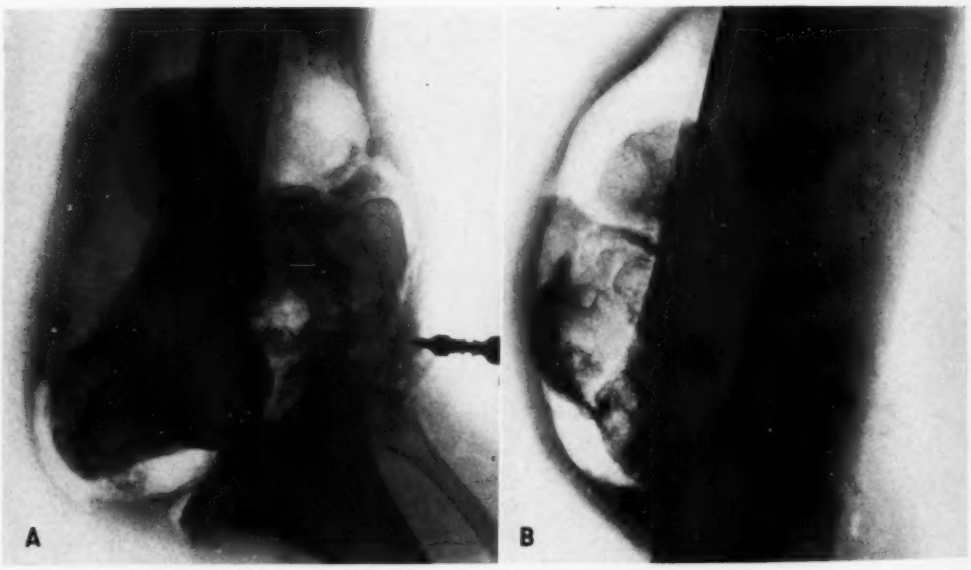


Fig. 12. Osteocartilaginous plaques resulting from Charcot joint. A. Anteroposterior arthrogram showing subluxation of the knee and large osteocartilaginous plaques. B. Lateral view of the same.

Rheumatoid Arthritis (*Fig. 14*): As has been hinted, the outer vascular stratum of the synovial membrane is the seat of reactive and reproductive changes. In rheumatoid arthritis, subchondral bone marrow is also involved, but inflammatory changes in the synovial membrane affect the articular cavity most. Inflammation of the synovial membrane runs through the usual gamut of hyperemia, edema, cellular infiltration, and tissue proliferation. It subsides with the formation of

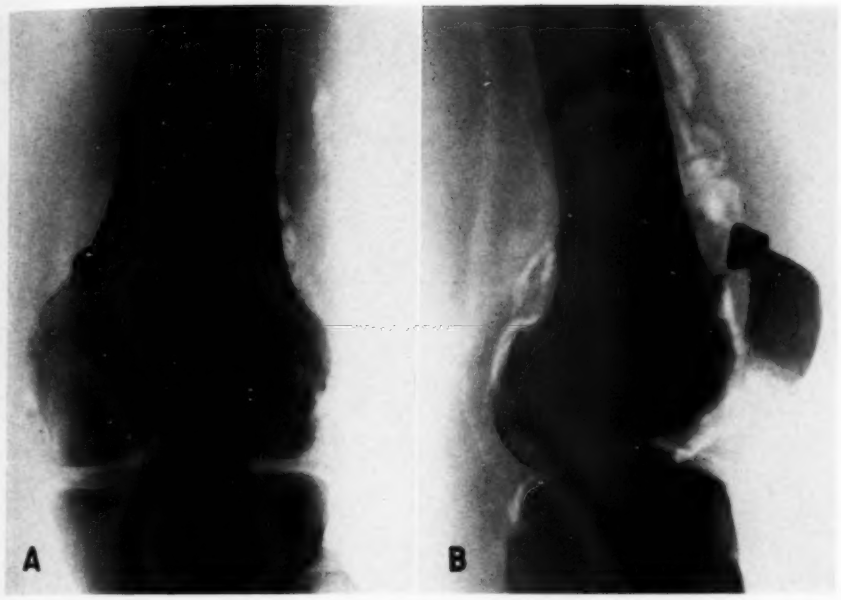


Fig. 13. Foreign body in the knee. A. Anteroposterior arthrogram showing a large metallic density (shrapnel) medial to the patella. B. Lateral view of the same. Note that the suprapatellar pouch is irregularly loculated due to the organization of the hematoma produced by the shrapnel. The septal effect is given by adhesions.

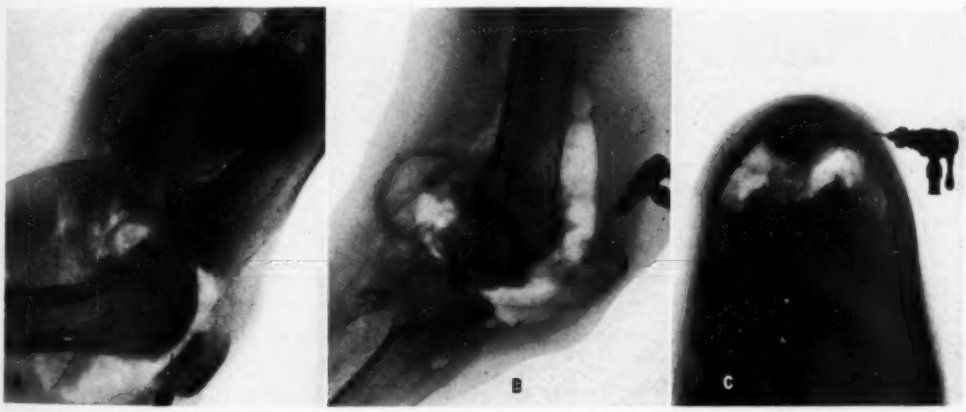


Fig. 14. Rheumatoid arthritis. Depending upon the stage of this inflammatory disease, arthrograms present a variable picture. When the expanded surface of the synovial membrane keeps on secreting fluid and fails to resorb it, the joint is distended; the articular cavity gains in capacity. Adhesions may partially or completely obliterate the joint space or produce the effect of multiloculation; villi, thickened synovial folds, and deposits of fibrin give rise to filling defects in arthrograms.

A. Lateral arthrogram of the knee taken with the patient lying flat on his belly and the knee partly flexed. Note the inordinately enlarged gastrocnemio-semimembranosus bursa extending to the level of the mid calf. At surgery it was found to communicate freely with the medial compartment of the knee. The mottled effect is produced by deposits of fibrin and thickened plicated synovial membrane.

B. Lateral view of the opposite knee of the same patient.

C. "Sky-view" of the knee shown in A. Thickened synovial folds and pannus have lifted the patella off the femoral condyles.

Fig. 15. Differentiation between villous phase of rheumatoid arthritis and the diffuse form of pigmented villonodular synovitis at arthrotomy. In the latter, the joint fluid is serosanguineous, the villi are thick-stalked, often nodular; there may be an apron-like fold cast over the articular cartilage but it does not adhere to or erode the hyaline surfaces. In rheumatoid arthritis, the joint fluid is tinged yellow; villi are fewer and may be interspersed with adhesions; there is usually true pannus invading and eroding marginal articular cartilage.

A. Photograph of surgically opened knee joint of a young girl suffering from "rheumatoid arthritis." Note the synovial pannus invading the articular surfaces of both femoral condyles—especially the external—and the pearly egg-shaped loose body beneath the medial condyle. (From Surg., Gynec. & Obst. **71:** 416–436, October 1940).

B. Same as Figure 15A, showing the erosion of the articular cartilage underneath the synovial pannus, which was wiped away during surgery. (From Surg. Gynec. & Obst. **71:** 416–436, October 1940).

C. Photograph at the time of arthrotomy of the knee of a girl aged 15 with familial pigmented villonodular synovitis. Her opposite knee is depicted in Fig. 16. Note the coarse nodular villi and apron-like fold cast over the articular surface of the femur (a false pannus).

D. The same as C, after synovectomy. The hyaline articular cartilage is not eroded.

scar tissue. In rheumatoid arthritis, granulations burgeoning in the vascular stratum of the synovial membrane may poke their way toward the articular cavity, throwing the lining of the joint into folds and finger-like projections. Synovial plicae and villi expand the secreting surface of the joint lining. More fluid pours into the articular cavity and distends it. Villi and plicae usually predominate when the inflammation is comparatively mild and where the synovial membrane is lax and can be pushed ahead. At the chondrosynovial junction, where the synovial membrane is fixed, the granulations break through the surface lining, creep over the hyaline plates, and erode them: they make contact with similar sproutings from subchondral bone mar-

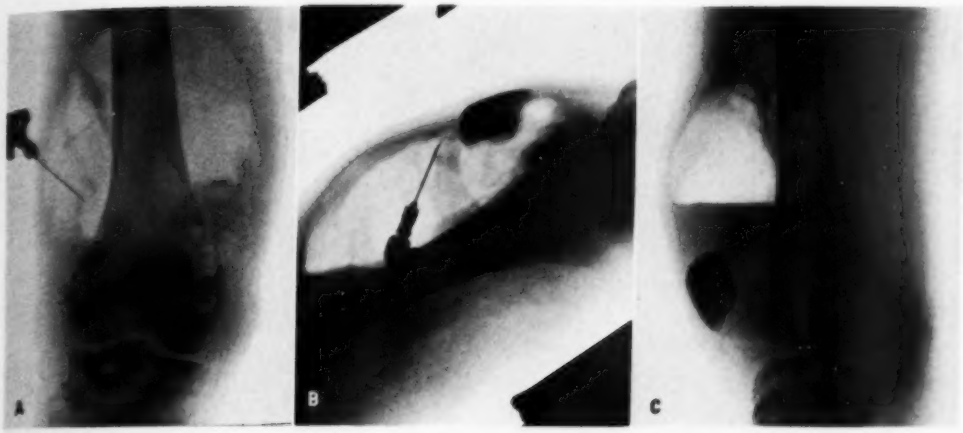


Fig. 16. Bilateral pigmented villonodular synovitis of the knee.

A. Anteroposterior arthrogram of the knee of a young girl whose two brothers were similarly affected. They all had bilateral effusion of the knees. One brother had, in addition, involvement of the wrist. There was thus a definite familial tendency. The photograph of one of the knees of this girl is shown in Fig. 15, C and D. Note in this arthrogram the extension of the suprapatellar pouch upward toward the mid thigh, the smooth articular contour and multiple loculations caused by infolding of the synovial lining.

B. Lateral arthrogram of the same.

C. Lateral arthrogram of the opposite knee, showing the fluid level and the effect created by villi.

row and from opposed synovial surfaces and form adhesions. The latter may become impregnated with bone and obliterate the joint space.

In rheumatoid arthritis, arthrograms give a variable picture. When villi predominate, the joint cavity gains in capacity; it contains fluid. When the intra-articular adhesions hold the upper hand, the joint cavity will admit less air; its lining will cast a jagged contour. Shadows indicative of adhesions and irregularity of the articular contour are more characteristic of rheumatoid arthritis than those denoting villi or other projections into the articular cavity.

Pigmented Villonodular Synovitis (*Figs. 15 and 16*): The condition which was formerly called xanthoma, giant-cell xanthoma, or benign synovioma shares some of the features of inflammation and of tumors. Tissue proliferation occurring in the vascular stratum of the synovial membrane may extend outward toward the capsule or inward in the direction of the joint cavity. In such joints as the radiocarpal or the posterior talocalcaneal, where the articular space is snug and will not permit any encroachment, proliferated tissue will grow outward, toward and through the capsule as a solitary tumor. In the knee the condition manifests itself in the form of localized or diffuse thickenings of the outer zone of the synovial membrane which push ahead the surface lining and hang into the articular cavity as villi and thick-stalked nodules. As in the villous phase of rheumatoid arthritis, the secreting surface of the synovial membrane is expanded, there is excessive joint fluid, and the joint cavity enlarges. As a result of the crowding of the villi together, some of them undergo intermittent pressure necrosis, and repeated aspirations will show the fluid to be serosanguineous. Reabsorbed blood gives the synovial surfaces a dark pigmented hue, and bruised villi may become matted in a mesh of friable fibrinous adhesions. In contrast to rheumatoid arthritis, however, granulations do not seem to break through the synovial surface and erode the articular plates: there is no true pannus. Surface-to-surface adhesions impeding the movements of the joint do not occur. Diagnosis of pigmented villonodular synovitis of a joint like the knee, with a large articular cavity, is made by (*a*) the repeated aspiration of serosan-

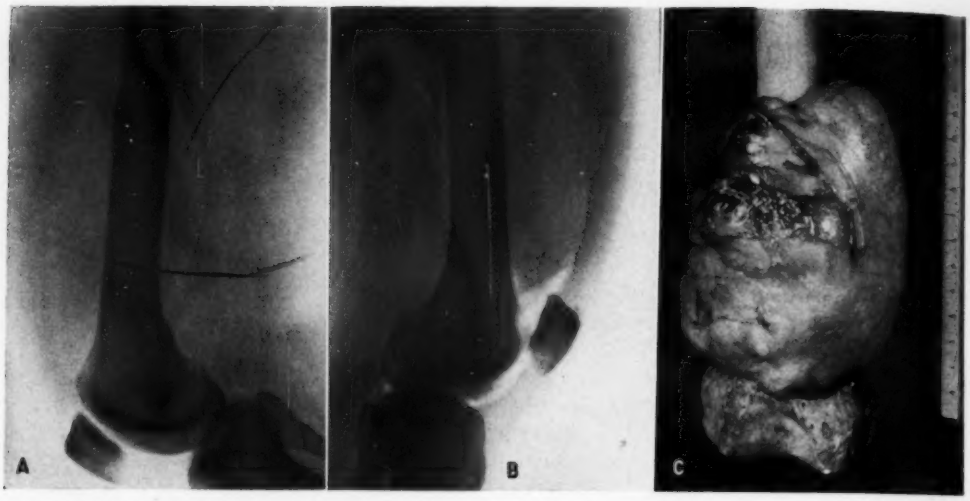


Fig. 17. Lipoma arising from the prefemoral fat pad and completely obliterating the suprapatellar pouch.
A. Lateral view roentgenogram of the knee. Note the radiolucent oval shadow.
B. Lateral arthrogram of the same knee. The suprapatellar pouch has been completely obliterated by the lipoma.
C. Photograph of the lipoma removed from the same knee. It is shown here in its relative position over a femur (dry specimen). At surgery, this lipoma was found to be extrasynovial but had carried the synovial surface in front of it, forward and downward into the joint. The tumor arose from a prefemoral fat pad.

guineous fluid in the absence of a history of hemophilia; (*b*) arthrograms which reveal an enlarged articular cavity containing fluid. The shadow cast by the joint cavity presents a smooth contour and gives a bubbly flocculent effect due to the filling defects produced by villi and nodules. Pigmented villonodular synovitis may be bilateral. It may be familial: one sister and two brothers were afflicted by it; they all had hydrops of both knees, and one brother had in addition swollen wrists.

Tumors (*Figs. 17–19*): Lipomata are perhaps the most common tumors which encroach upon the joint cavity and create filling defects in arthrograms. Fat is found normally around joints which permit free movement. Fat facilitates motion. Articular fat is laid diffusely or in compact lumps. When several discrete rounded tendons hug the joint capsule or play upon the articular ends of bones, adipose tissue fills their interstices diffusely; where the tendons are conjoined into flat aponeurotic cords and have to use the skeletal prominences as fulcra, one or more pads of fat intervene between them and the synovial sac, or between the latter and the underlying bone. To put the same principle on a functional basis, loose fat is found on the side of the joint toward which greater range of movement is allowed; compact pads cushion the side of the joint in the direction of which movement is limited. Lipomata arise more commonly from confined cushions of adipose tissue than from loose areolar fat; they occur, therefore, on the side of the joint toward which movement is limited.

In the knee, organized articular fat pads are found on its extensor aspect. The prefemoral fat pad saddles the distal articular end of the thigh bone and supports the posterior synovial lining of the suprapatellar pouch; the infrapatellar fat pad fills the space between the extensor tendon in front and the synovial lining of the anterior chamber of the knee. Hypertrophy of the infrapatellar fat pad is a well recognized clinical entity, but it is not generally recognized that the more sluggish prefemoral cushion is a more common source of true lipomata. In arthrograms, lipomata are recognized by their location

in front of the knee, more commonly above than below the patella. Prefemoral lipomata may be so large as to obliterate the suprapatellar pouch completely or they may be small and create a partial filling defect in the arthrogram. Both the prefemoral and infrapatellar fat pads may contain calcific deposits simulating osteocartilaginous bodies. Filling defects of the articular cavity may also be caused by hemangioma, synovial ganglia, polyps, fibroma and enchondroma. In the arthrogram, the shadow cast by a hemangioma is dense; it is usually speckled with opacities indicative of sclerotic vessels and phleboliths. Synovial cysts and ganglia occur more often near the circumferential border of the menisci; synovial fibroma and chondroma cast denser shadows than lipomata. Synovioma is an extremely rare tumor.

Intra-articular Chip Fractures and Conditions Confused with Them: The question often arises as to whether a small density seen on the x-ray film represents a phlebolith, an osteocartilaginous body, a sesamoid bone, a separate center of ossification, a piece of bone pinched off by compression, or an avulsion ossicle.

Phleboliths present an amorphous texture; they may have concentric rings but show no markings indicative of true trabeculae. In arthrograms air does not contact or surround them.

Osteocartilaginous loose bodies which arise from the synovial membrane have less organized trabeculae than those which originate from bone as a result of avascular necrosis; chipped-off ossicle presents the same pattern as the mother bone. In the latter both primary (or longitudinal) and secondary (or transverse) trabeculae are discernible. Long standing osteocartilaginous bodies, especially in such joints as the shoulder, where circumduction is a common movement, will show lamellated concentric trabeculae, not to be confused with the amorphous rings seen in phleboliths. In arthrograms, air surrounds osteocartilaginous loose bodies.

Fabella, which is seen often in relation with the lateral head of the gastrocnemius muscle, is a sesamoid bone. It has a cartilage-coated facet which parallels the posterior articular surface of the lateral condyle. The texture is finer than that of osteocartilaginous bodies. Sesamoid bones possess no coarse longitudinal trabeculae and delicate markings indicative of secondary trabeculae running transversely, at an angle to the articular surface. In true lateral-view arthrograms, the fabella appears tangent to, but is not surrounded by, the shadow cast by air introduced into the main articular cavity.

Fig. 18. Lateral arthrogram showing a vascular tumor encroaching upon the suprapatellar pouch, giving rise to a saddle-shaped filling defect. Note that the tumor cast a dense shadow, denser than fat. It was surgically removed and was found to be an extremely vascular fibrous tumor.

Separate *centers of ossification*, which may be confused with fractures, are most often seen in relation with the superior and lateral cornua of the patella and the posteromedial tubercle of the talus. They are usually bilateral and are connected with the main bone by a plate of fibrocartilage. In sky-view arthrograms of the knee, air does not penetrate the interspace seen in the outer wing of the *bipartite patella*. In fractures it does. A fibrocartilaginous plate also connects the *os trigo-*

Fig. 19. Polypoid tumor creating a filling defect.
A. Postero-anterior arthrogram of knee showing a filling defect on the medial aspect of the suprapatellar pouch.
B. Oblique anteroposterior view of same showing a rounded density above the medial condyle of the femur.
C. Photograph of the knee at the time of arthrotomy, showing a pedunculated polyp.

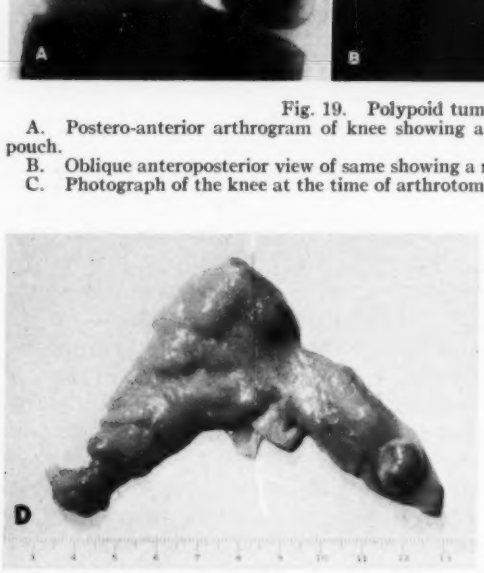


Fig. 19D. Same case as Fig. 19, A–C. Photograph of the surgically removed specimen. Note the nodular tumor surrounded by turgid synovial membrane. Pathological report on this tumor was pleomorphic-cell tumor of the synovial membrane.

num with the main body of the talus so that air introduced into the ankle joint above the talus does not usually enter the posterior talocalcanean articulation. Due to its compression between the posterior lip of the tibia above and the superior articular dome of the os calcis below, the *posteromedial process of the talus becomes at times pinched off* and allows the ankle joint to communicate freely with the rear talocalcanean articulation. Air introduced into the ankle above will then pass into the subtalar joint below.

Avulsion ossicles produced by sprain fractures are intratendinous or intraligamentous. They usually lie outside the articular cavity. Where the ligament blends intimately with the joint capsule, as in the case of the deltoid ligament of the ankle and the medial collateral ligament of the knee, the avulsed ossicle will border on the shadow cast by the air within the articular cavity.

30 N. Michigan Blvd.
Chicago, Ill.

REFERENCES

BERNSTEIN, M. A., AND ARENS, R. A.: Diagnostic Inflation of the Knee Joint: A Clinical-Radiological Study. Radiology **7:** 500–505, 1926.

BLONEK, F., AND WOLF, J.: Pneumoradiography of the Knee Joint. J. Iowa. M. Soc. **34:** 354–360, 1944.

BOYD, D.: Knee-Joint Visualization. A Roentgenographic Study with Iopax. J. Bone & Joint Surg. **16:** 671–680, 1934.

CHANDLER, F. A.: Congenital Abnormalities of the External Semilunar Cartilage. S. Clin. North America **17:** 331–334, 1937.

CHRISTOPHER, F.: Displacement of the Internal Semilunar Cartilage in a Boy of Four Years. J. Bone & Joint Surg. **6:** 918–919, 1924.

COLP, R., AND KLINGENSTEIN, P.: Roentgen-Ray Study of the Injected Knee Joint. Arch. Surg. **11:** 660–773, 1925.

ELLIS, V. H.: Congenital Abnormality of the External Semilunar Cartilage. Lancet **1:** 1359, 1932.

KELIKIAN, H.: Posterior Approach to the Knee. S. Clin. North America **27:** 157–181, 1947.

KELIKIAN, H.: Pathological Physiology of Joints. Surg., Gynec. & Obst. **71:** 416–436, 1940.
KLEINBERG, S.: Pulmonary Embolism Following Oxygen Injection of a Knee. J. A. M. A. **89:** 172–173, 1927.
KLEINBERG, S.: Artificial Pneumoarthrosis as an Aid in Diagnosis. M. J. & Record **121:** 341–343, 1925.
KREUSCHER, P. H., AND KELIKIAN, H.: Use of Iodized Oil (Lipiodol and Iodipin) in the Diagnosis of Joint Lesions. Surg., Gynec. & Obst. **50:** 888–890, 1930
LINDBLOM, K.: Roentgenographic Symptoms of Meniscal Lesion in the Knee Joint: Contribution to Question of Connection Between Meniscal Lesion and Arthrosis. Acta radiol. **21:** 274–285, 1940.
MCGAW, W. H., AND WECKESSER, E. C.: Pneumoarthrograms of the Knee: Diagnostic Aid in Internal Derangements. J. Bone & Joint Surg. **27:** 432–445, 1945.

SUMARIO

Artrografías

Como medio de contraste para el estudio radiográfico de las articulaciones, el aire muestra las siguientes ventajas. Se halla siempre a mano; es más radioluciente que el trasudado o exudado articular, y que el tejido adiposo, muscular o cartilaginoso; contrasta bien con la cápsula articular y los tejidos articulares accessorios; penetra, delineándolos, en todos los compartimientos de la cavidad articular; se desliza, a través del istmo más estrecho, a los divertículos que pueden comunicarse con dicha cavidad; se absorbe rápidamente, y es inocuo.

En los miembros inferiores, la rodilla y el tobillo son los que se prestan mejor para la artografía. Los artrogramas de la cadera, enterrada, como está, en músculos voluminosos, son los que aportan menos información. En los miembros superiores, el codo es el que da más satisfacción con este método.

Tomando como ejemplo la rodilla, los AA. describen las cinco posiciones clásicas que se necesitan para revelar los pormenores del contorno, la capacidad, contenido y comunicaciones de la articulación. Son la anteroposterior con el enfermo en decúbito dorsal; posteroanterior con el enfermo de rodillas; decúbito lateral con el enfermo recostado del lado afectado; vista lateral con el enfermo en decúbito dorsal y rodilla extendida; y proyección lateral con el enfermo en decúbito prono y la rodilla en flexión parcial. Otras vistas que pueden necesitarse son: tangencial u "horizontal"; anteriores y posteriores con el enfermo de pie: oblicuas con el enfermo en decúbito ventral; anteroposteriores con el enfermo de lado y el tubo de rayos X paralelo a la porción superior de la mesa. La calidad de los rayos usados es la destinada a tejidos blandos más bien que al hueso. Con un tubo de ánodo rotatorio los siguientes factores técnicos han resultado satisfactorios para la mayoría de las rodillas: en la posición anteroposterior, kilovoltaje 56, miliamperaje 100, tiempo un vigésimo de segundo, distancia foco-placa 1 m.; en la posición lateral puede rebajarse el kilovoltaje en 2 kv.

La anatomía de la rodilla, según la revela la artrografía, es discutida a fondo, presentándose los hallazgos para: lesiones de los cartílagos semilunares; extravasaciones sinoviales, como en el llamado quiste de Baker; cuerpos osteocartilaginosos; artritis reumatoidea, sinovitis villonodular pigmentada, tumores; y por fin, estados tan confusos como flebolitos, cuerpos osteocartilaginosos flotantes, huesos sesamoides, centros separados de osificación, fragmentos óseos desligados por la compresión y osículos de avulsión.

Electrokymography of the Heart and Great Vessels

Correlation with Roentgenkymography in Clinical Case Studies[1]

HERBERT M. STAUFFER, M.D., and JOSEPH JORGENS, M.D.

Minneapolis, Minn.

A NUMBER OF efforts have been made to translate the changes in x-ray intensity produced by pulsating vascular structures in the chest into recordable variations of electrical potential. Jacobi, Janker, and Schmitz (12) in 1932 reported use of an ionization chamber and mirror galvanometer to record changes in x-ray absorption due to heart-border pulsations. Later Heckmann (7) described what he called "actinocardiography," a method using a photoelectric cell and galvanometer to obtain a graph of the changes in density of the entire cardiac image on the fluoroscopic screen; the records published show very little detail, except that the pulsations of the x-ray tube power supply are accurately reproduced. Henny and Boone (8) applied the tremendous sensitivity of the electron-multiplier phototube to this problem and first reported on their "electrokymograph" in 1945. The device was subsequently improved (9) and, as a convenient fluoroscopic accessory which readily provides records with a wealth of detail, it represents the first practical device of this sort. The present report is based upon experience with this instrument.

In 1946 Hjelmare (10) published records of heart-border motion obtained with a Geiger counter together with simultaneous electrocardiograms. In the same year Marchal (15) described "kine-densigraphy" of the pulmonary parenchyma, in which a photocell and amplifier were employed to obtain a graphic recording of variations in density of the lungs with the peripheral vascular pulsations; he applied the same method in kymography of the heart and great vessels. The records published by Marchal show good detail and are quite similar to those obtained with the electrokymograph of Henny and his associates. At the same time, Lian and Minot (14) reported a modification of Marchal's technic, which they termed "radioelectrokymography"; these workers project the electrokymographic curve and the tracings of the three leads of the electrocardiogram simultaneously on the screen of an oscilloscope during fluoroscopy of the heart, the fluoroscopist then making recordings at will simply by switching on a camera.

Electrokymography represents a distinct advance over multiple slit roentgenkymography in that accurate timing with carotid pulse and/or heart sounds is readily feasible; this facilitates identification of a particular type of motion with a definite interval in the cardiac cycle, placing the roentgenologic analysis of cardiovascular pulsations on a sound physiologic basis. The present report is based on a preliminary study of 20 normal young adult males and a small group of abnormal cases representing a variety of cardiovascular conditions. A portion of this material has been briefly discussed in a previous publication (18).

APPARATUS AND TECHNIC

The apparatus employed in this study was the improved electrokymograph described by Henny *et al.*[2] Both the string galvanometer electrocardiograph (Cambridge) and the vacuum tube oscillograph (Sanborn) have been employed for recording at various times, with equally good results and without alteration in the electrokymograph circuit.

The electrokymograph consists of a pickup containing an electron-multiplier tube

[1] From the Department of Radiology and Physical Therapy, University of Minnesota. Aided by a grant from the Graduate School Research Fund. Accepted for publication in March 1948.

[2] The electrokymograph used in this investigation was supplied by the Heart Demonstration Section, U. S. Public Health Service, Philadelphia, Penna.

(931-A) which responds to fluctuations in illumination from a strip of fluorescent screen, produced by variation in x-ray transmission in the subject. A 1,000-volt direct-current power supply is required for the phototube. The area of the body scanned is limited by a metal diaphragm, 0.8 × 2.5 cm.; the pick-up is placed between the screen of the fluoroscope and the patient and is mounted so that the slit rotates in the central x-ray beam; the x-ray beam can thus be shuttered down during recording so as to minimize exposure of the patient and improve definition. An electrical filter must be interposed between the multiplier tube and the recording galvanometer, since the tube responds to the 120- or 60-cycle-per-second fluctuation in the x-ray beam depending on whether the input to the x-ray tube is full- or half-wave rectified. (The response of the device to these frequencies is an indication of its promptness of response, which for the practical purpose of recording cardiac events may be regarded as instantaneous.) Excellent results have been obtained with the 120-cycle filter and full-wave rectified x-ray sources. Tests which we have made with radon as a source of non-pulsating radiation, with mechanical interruption of the beam by a rotating lead sector disk, show that, while the 120-cycle filter produces slight but appreciable distortion of the wave form, the promptness of initial response of the system is not impaired significantly. Interposition of the filter decreases the potential variation of the phototube output so that some form of vacuum tube amplification would have advantages in dealing with thick subjects, especially in the lateral view. No amplification was employed in this study, the frontal projection being used throughout in securing the records.

Correlation of the electrokymographic curves with cardiac systole and diastole is essential for interpretation. We have made use of both carotid-pulse and heart-sound recordings as provided with the electrocardiographic machine. All records were made in the upright position, and it was found feasible to have the patient hold the microphone to pick up the heart sounds over the precordium in such a position that the portion of the heart border being recorded with the electrokymograph was not obstructed. Artefacts are difficult to avoid both with the heart-sound and carotid-pulse recordings. We have preferred the carotid-pulse record for timing since, even in the presence of artefacts, the onset of systolic ejection is usually obvious; cardiologists more conversant with heart-sound records may well find them more satisfactory. In some instances, heart sounds, carotid pulse, and the electrokymogram were recorded simultaneously, but this complicated the technic of recording unnecessarily. To obtain satisfactory results demands a certain amount of teamwork, developed by experience, between the fluoroscopist who selects the desired area for recording and his assistant who operates the electrocardiographic galvanometer and adjusts the pulse or heart-sound records.

INTERPRETATION OF NORMAL RECORDS

In accordance with the usual convention, the electrokymograph leads are so connected to the galvanometer that upward deflection on the tracing represents outward motion, and downward indicates inward movement of the heart border. Since recordings of density changes are also obtained when the pick-up slit is not actually over the border of a pulsating structure, upward deflection signifies increase in density, and downward the reverse. Timing is by the usual electrocardiograph time marks, each small vertical division representing 0.04 second; camera speeds more rapid than 25 mm. per second have not been found necessary in this study.

Interpretation of electrokymographic tracings in terms of the subdivisions of the cardiac cycle generally employed by physiologists has been described by Boone *et al.* (2); this corresponds closely to that presented by Hirsch and Gubner (11) in an analysis of roentgenkymography. For the present purpose, a brief description of a

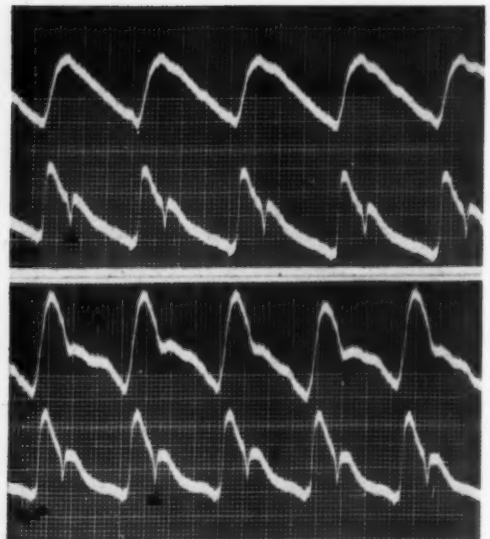


Fig. 1. Records from normal adult subject. EKY. Electrokymogram. AK. Aortic knob. PA. Pulmonary artery. CP. Carotid pulse. LLB. Left lower border. d. Dicrotic notch of carotid pulse. i. Incisura.

normal record will suffice. The electrokymograms of the aorta and pulmonary artery are most susceptible of straightforward interpretation in physiologic terms. To simplify the preliminary work described herein, all recording was done in the frontal view. Aortic recordings were from the aortic "knob." Pulmonary-artery recordings were made from the "pulmonic arc" immediately below the aortic knob; to clear the pulmonic or second left arch from the shadow of the descending aorta in some subjects required slight rotation into the right anterior oblique position. From the findings of angiocardiography, this area probably represents the main pulmonary artery and its left main branch (5, 6).

The great-vessel electrokymograms simulate very closely the pressure curves of these vessels as recorded experimentally (20). In Figure 1, the sharp upstroke of the aortic knob and pulmonary artery recordings will be seen to coincide closely with that of the carotid pulse. (Chamberlain *et al.*, 3, have shown by this means that actually there is commonly measurable asynchronism between the ejection from the two ventricles in the normal heart; marked asynchronism can be demonstrated in bundle-branch block.) The downward movement is more gradual and is usually interrupted by the incisura produced by closure of the aortic and pulmonic valves; this incisura corresponds to that of experimental central arterial pressure tracings.

The aortic and pulmonary tracings are usually distinguishable from each other by a variation in the character of the downward (diastolic) segment. The aortic ordinarily shows a plateau-like summit and gradual descent, with the incisura occurring shortly after the peak is reached; the pulmonic regularly shows a prompt and steep descent which is interrupted by a more prominent incisura and dicrotic wave. The pulmonary-artery kymogram resembles the peripheral pulse with its prominent dicrotic notch, while the aortic is more like the experimental central arterial-pulse tracings. This may be related partly to lower peripheral resistance in the pulmonary circuit. That the transformation from the central to the peripheral type of pulse wave form occurs over a very much smaller linear distance in the pulmonary than in the systemic circulation has been observed by Johnson *et al.* (13) experimentally; the change in wave form apparently depends more on degree of branching than on linear distance.

Simultaneous recording of heart sounds provides additional information about the mechanical events in the heart. The interval between the onset of the first sound and the foot-point of the upstroke of the aortic or pulmonary artery electrokymogram represents the phase of isometric contraction;

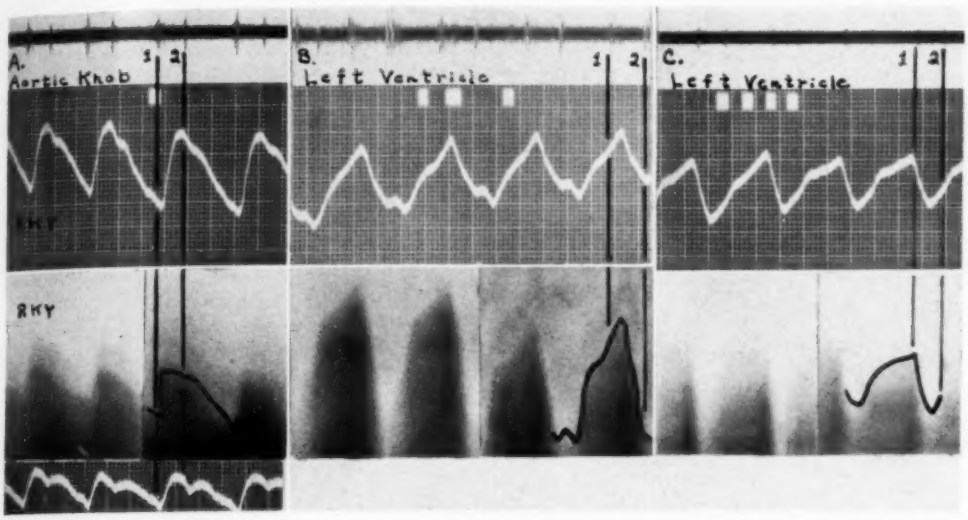


Fig. 2. Correlation of normal electrokymograms with roentgenkymogram. Segments of the roentgenkymogram have been enlarged and arranged for comparison with the corresponding electrokymograph tracings and heart sounds.

A. Aortic knob. Lowermost record is electrokymograph "density curve" from the aortic knob; the amplitude is diminished as compared with that over the border, but the details are preserved. B and C. Portions of the left ventricular border (frontal view) in two normal subjects.

1 and 2. Heart sounds. RKY. Roentgenkymogram. EKY. Electrokymogram.

during this initial period of ventricular contraction, the intraventricular pressure is raised without change in ventricular volume until the pressure equals that in the great vessels, at which time ejection begins. The end of systole is marked by the first oscillations of the second heart sound, representing valve closure, and in our records preceding the bottom of the incisura of the aortic and pulmonary kymograms by as much as 0.10 second. Tracings recorded from the pulmonary arteries in the hilar regions show essentially the same features.

It is not yet clear to what extent volume change contributes to the electrokymogram as opposed to the contribution of positional change. Weltz (19), on the basis of roentgenkymograms, concluded that positional change of the aortic arch exceeded the actual volumetric change. It is possible, however, to secure "density curves" with all the features described above by centering the pick-up of the electrokymograph directly over the center of the aortic arch as visualized end-on in the frontal view at the level of the knob (Fig. 2A); this should minimize positional factors and the record should thus be principally volumetric in this instance.

The tracings obtained over other portions of the heart are much more variable and difficult to interpret than are the vascular curves. This is in large part due to the effect of positional changes as emphasized by Zdansky and Ellinger (21), Heckmann (7), Roesler (16), and others. The left border curves are fairly constant in character, with the major inward movement occurring in systole and the major outward motion in diastole. The principal variations on this theme occur in the periods of isometric contraction at the upper peak and isometric relaxation at the foot of the curve and may be related to preponderant positional changes occurring at these times, as suggested by Boone *et al.* (2).

Marchal (15) attributes the small undulations at the peak in early systole to retrograde waves from the aorta; the small undulations at the foot of the curve he feels may be related to closure of the

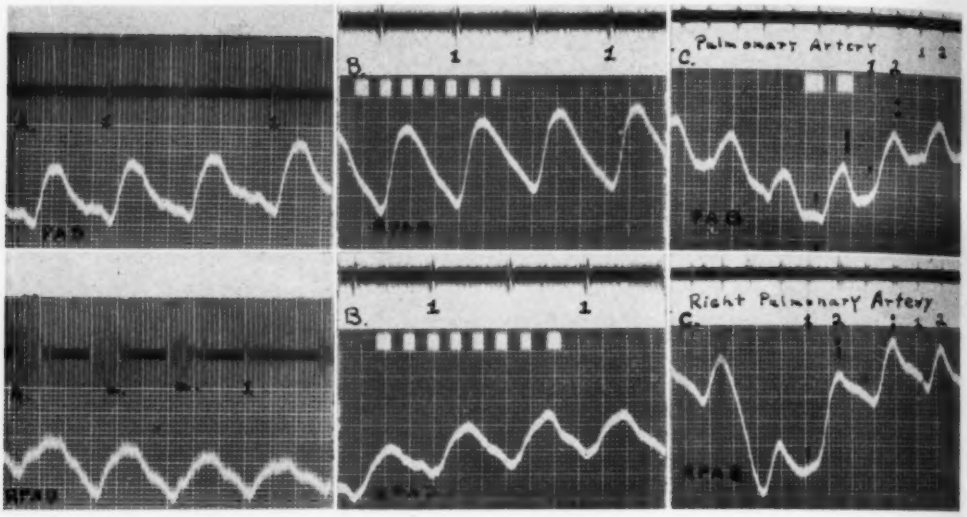


Fig. 3. Pulmonary artery electrokymograms (interatrial septal defect), A, B, and C representing Cases I, III, and IV, respectively.

No density change could be recorded from the enlarged right pulmonary artery (Fig. 4) in Case IV, although the vessel border shows rather characteristic arterial type waves.

PAB. Pulmonary artery border. RPAD. Right pulmonary artery density. RPAB. Right pulmonary artery border. 1 and 2. Heart sounds. a. Artefacts in sound record. Note murmur in sound record in B.

semilunar valves, as suggested also by Hirsch (11) to explain a similar oscillation in the roentgenkymogram. Rather complex curves are encountered along the right border with varying combinations of right atrial and right ventricular motion in the lower segment and of aortic and superior vena cava activity in the upper, vascular segments.

Identification of the exact chamber being recorded, especially in the oblique views and in pathological cases, will be greatly facilitated where angiocardiograms of the patient are available. This technic has not been employed in the present group of cases.

COMPARISON WITH ROENTGENKYMOGRAM

Figure 2 illustrates the general similarity of both the vascular and the left border curves in the roentgenkymogram and the electrokymogram. Segments from the x-ray film record of the same areas represented in the electrokymographic tracing have been enlarged so that the time relationships are approximately the same. The two sets of left ventricular curves are from two normal students and illustrate some of the individual variations encountered. Considerable variation likewise is found between various points on the ventricular border with both methods. The superiority of the electrokymogram in clarity, wealth of detail, and ease of correlation with other phenomena (*i.e.*, sounds or carotid pulse) is obvious.

Not so obvious is the fact that the roentgenkymogram distorts all movement not parallel to the slits of the kymograph grid. Batt (1) has recently called attention to an additional source of error with this method; variations in the ratio of film velocity to heart rate may produce variations in contour of the heart border curves in the roentgenkymogram. Both methods are subject to many of the errors arising from the geometrical factors in connection with the irregular oscillation and pulsation of an asymmetrical body such as the heart; these have been well discussed by Schwarzchild (17) in a critical evaluation of kymography. Artefacts due to oscillation of the heart along the axis of the diverging x-ray beam are overcome with the electrokymo-

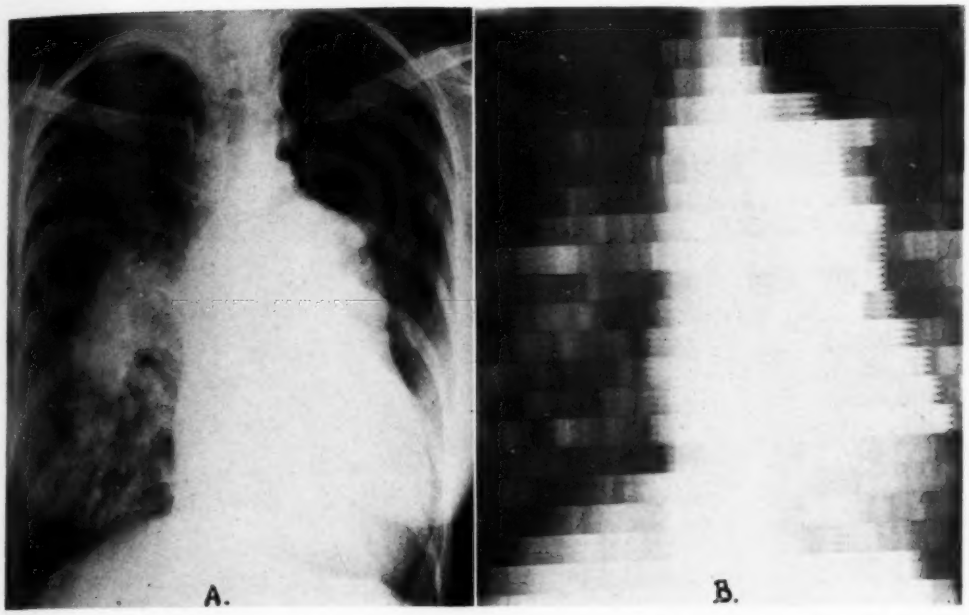


Fig. 4. Case IV (interatrial septal defect). A. Roentgenogram of chest showing tremendous dilatation of pulmonary artery and its branches, especially on the right. B. Roentgenkymogram. Right pulmonary artery branches show marked pulsations, but zig-zag pattern when both borders are considered suggests transmitted pulsations.

graph where the central beam is employed tangent to the border being studied.

The roentgenkymogram provides information about relative amplitude of movement, where the heart border is perpendicular to the slits, that is at present unobtainable with the electrokymograph. The amplitude of pulsations obtained with the latter depends on an electrical adjustment. The multiple slit kymogram has the further advantage of presenting a survey of pulsations all along the borders of the cardiac silhouette on a single film record. While electrokymography can stand on its own merits as a method of recording and analyzing movements observed fluoroscopically, it also must be regarded as a useful refinement to be used in conjunction with roentgenkymography.

CLINICAL CASE STUDIES

A. Interatrial Septal Defect

CASE I: D. W., a 22-year-old female student, gave a history of known heart disease from infancy. She was slight of build but there was no cyanosis and no clubbing of the digits. There was dyspnea on exertion. A loud systolic murmur was transmitted over the entire precordium and to the neck. *Fluoroscopy* and *roentgenography* revealed a very large globular cardiac silhouette with enlargement predominantly of the right ventricle. The pulmonary artery and its branches were greatly enlarged, and the latter showed marked pulsations, apparently intrinsic. The only unusual finding in the *roentgenkymogram* was the aortic knob wave form showing three small peaks. The *electrokymogram* from the aortic knob was likewise atypical; there were an exceptionally deep incisura and a corrrespondingly large secondary wave. Pulmonary artery border and density curves showed no unusual features. ("Density curves," as mentioned previously, are obtained with the pick-up placed within the margins of the vessel in an attempt to minimize the effect of positional change of the vessel as a whole.) Border and density deflections (Fig. 3A) of good amplitude were obtained from the enlarged right pulmonary artery branches in the hilar region.

Three months after the x-ray studies the patient died following laparotomy for a ruptured ovarian follicle. *Autopsy* disclosed an interatrial septal defect 2.5 cm. in diameter. The pulmonary artery was approximately twice the diameter of the aorta. There was some scarring of the mitral valve but no significant stenosis.

CASE II: J. G., a Negro male student 29 years of age, had congenital heart disease recognized in in-

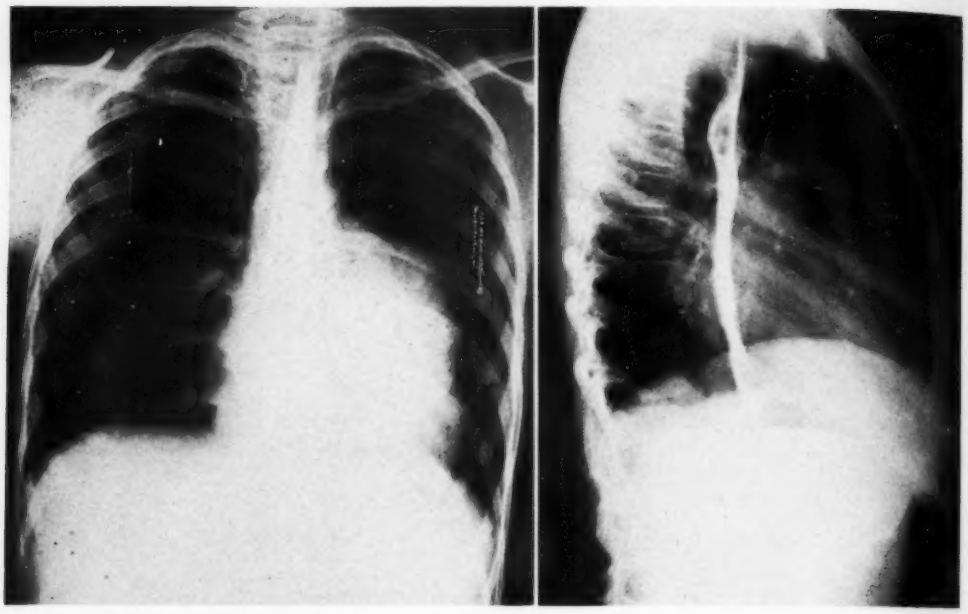


Fig. 5. Case V (mitral stenosis and insufficiency). Roentgenograms of chest show left atrium greatly enlarged to the left and posteriorly; very slight displacement of esophagus to the right.

fancy. He was small of stature and complained of dyspnea on exertion. A loud, high-pitched systolic murmur was heard at the third interspace over the sternum, and the second pulmonic sound was loud over the entire precordium. There was a systolic thrill over the precordium. *Roentgen* examination showed a very large pulmonary artery and branches, with enlargement of the right ventricle, findings which, with the clinical picture, indicated an interatrial septal defect. The *roentgenkymogram* showed expansile-type pulsations over portions of the right hilar pulmonary vessels; in some portions, transmitted motion appeared to predominate. The aortic curve in the *electrokymogram* was somewhat atypical, with a rather broad plateau at the summit bearing a well defined incisura. The pulmonary artery and its right hilar branch yielded normal border electrokymograms. No effort was made in this case to record density curves from the pulmonary vessels.

CASE III: R. C., a young man 22 years of age, was referred by Dr. M. J. Shapiro for roentgenologic study, with the clinical diagnosis of interatrial septal defect with mitral stenosis (Lutembacher's syndrome). There was marked bulging of the precordium. Along the left border of the sternum and out into the left chest a loud systolic murmur was heard, followed by a long, loud, blowing diastolic murmur. The second pulmonic sound was moderately accentuated. *Roentgenologically* there was enlargement of the right ventricle and of the pulmonary artery and its branches. There was no evidence of left ventricular or of left atrial enlargement. Two *roentgenkymograms* were unsatisfactory technically. The aortic and pulmonary artery *electrokymograms* (Fig. 3B) showed no unusual features. Ample density fluctuations were recorded over the right pulmonary artery branch.

CASE IV: L. A., a 28-year old female, had been cyanotic from birth. She had always been dyspneic, and clubbing of digits had been noted early in life. She was married at the age of twenty-one years and at twenty-four gave birth to a 3 lb. 13 oz. baby by the normal route. A loud, blowing systolic murmur was audible in the fourth left interspace. In the third left interspace, a diastolic thrill and diastolic murmur were noted. The pulmonic second sound was accentuated. *Roentgenologically* (Fig. 4A) the dominant feature was the tremendous dilatation of the pulmonary artery and its branches; on the right the pulmonary artery attained aneurysmal proportions. The right ventricle was greatly enlarged, but there was no evidence of left atrial or left ventricular enlargement. Exaggerated pulsation of the pulmonary vessels was noted fluoroscopically and in the *roentgenkymogram* (Fig. 4B). The vessels on the right show a "zig-zag" pattern in the roentgenkymogram which suggests that positional movement of the vessel as a whole predominates over expansile pulsation. The diagnostic impression was interatrial septal defect, possibly with mitral stenosis.

The *electrokymogram* showed an atypical aortic knob tracing with an unusually deep incisura and a low secondary wave; the curve was somewhat like

that in Case I. Pulsations of the border of the huge right pulmonary artery were readily recorded (Fig. 3C) but with the pick-up slit of the electrokymograph placed vertically and within the confines of the vessel there was negligible deflection, indicating practically no density change.

Comment: Three of the above four cases of interatrial septal defect showed atypical aortic electrokymograms. It seems very probable that the alterations in the contours of these tracings arise from the changed hemodynamics associated with

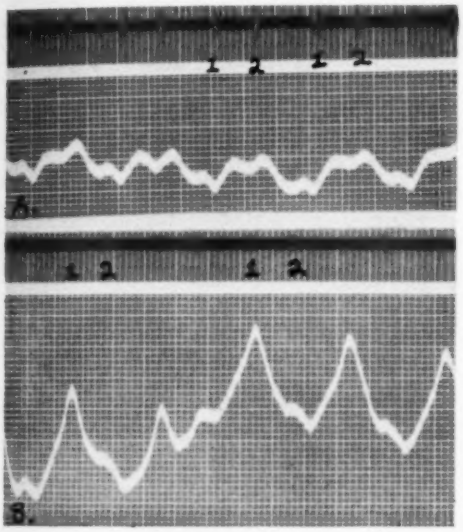


Fig. 6. Case V (mitral stenosis and insufficiency). Electrokymograms. A. Border of dilated left atrium. Complex outward movement during systole, probably representing combined effects of mitral regurgitation and auricular components. B. Lower left border. Normal ventricular inward movement during systole, outward in diastole.
1 and 2. Heart sounds.

the intracardiac shunt; another possible factor is transmitted motion from the adjacent huge pulmonary artery. It is remarkable that the records from the enlarged pulmonary arteries show no significant deviation from the usual wave form. The left and right heart border pulsations likewise were not unusual.

In Case IV the absence of detectable density variation with the electrokymograph over the greatly dilated right pulmonary artery branch correlates well with the roentgenkymographic finding suggesting predominantly positional change of the whole vessel. These two findings are strongly suggestive of thrombosis within the aneurysmal right pulmonary artery.

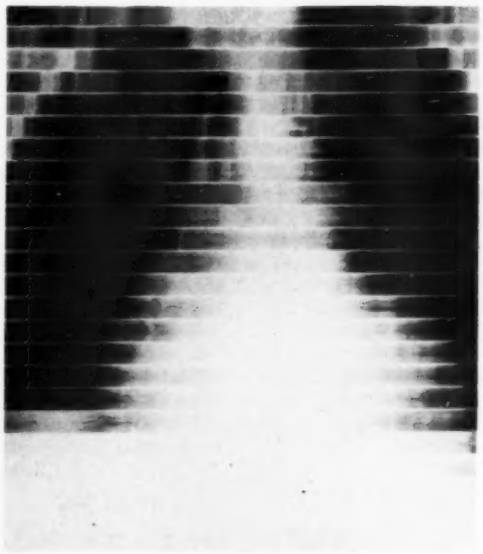


Fig. 7. Case VI (tricuspid regurgitation). Roentgenkymogram showing large amplitude of aortic and ventricular pulsations. The superior vena cava is widened; the character of its pulsations is not readily distinguishable.

B. Enlarged Left Atrium Presenting on the Left Cardiac Border

CASE V: E. H., a girl 10 years of age, was admitted to the hospital with paralysis of the right arm and leg and clinical evidence of a double mitral valvular lesion. She ran a septic febrile course with markedly elevated sedimentation rate. The clinical diagnosis was cerebral embolus from a focus of bacterial endocarditis, and rheumatic mitral valvular disease. The electrocardiogram showed right axis deviation and a prolonged PR interval. One blood culture was positive for alpha hemolytic streptococci. Following nine weeks of intensive penicillin therapy, the patient became afebrile and the hemiparesis gradually improved.

Roentgenologic study revealed a remarkable cardiac silhouette, with a huge, rounded mass projecting from the left middle contour in the frontal view and posteriorly in the lateral view (Fig. 5); the esophagus was displaced slightly to the right but not posteriorly. Only a small segment of normal appearing lower left contour is visible in the frontal view. These findings were interpreted as indicating atypical protrusion to the left of a greatly enlarged left atrium in the presence of mitral valvular disease.

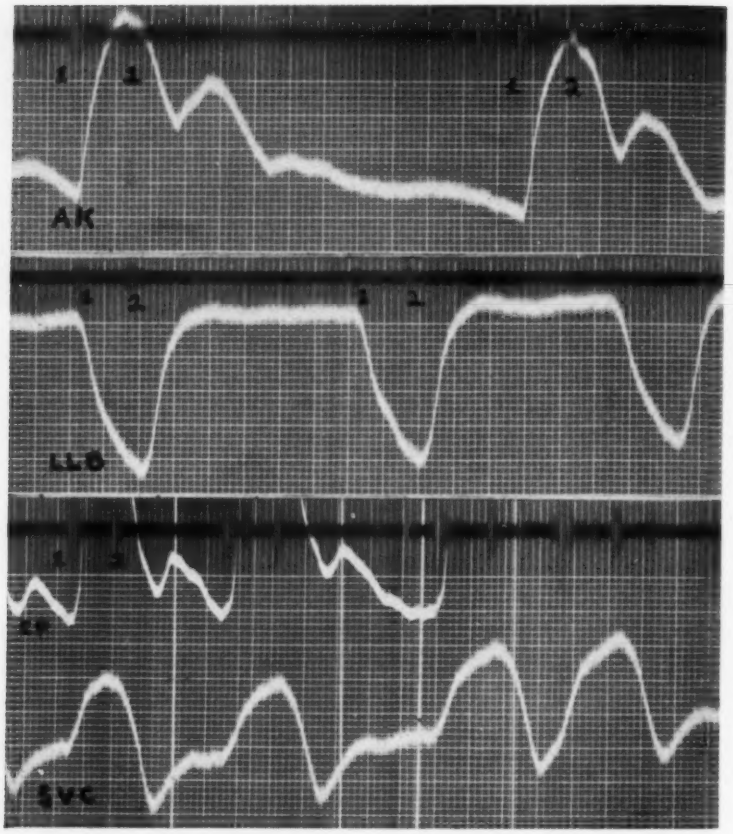


Fig. 8. Case VI (tricuspid regurgitation). Electrokymograms. Auricular fibrillation with slow, totally irregular pulse. Note large amplitude of aortic pulsations. Ventricular pulsations (LLB) show normal inward movement in systole. Systolic outward movement of superior vena cava is readily apparent from electrokymogram but could not be recognized on roentgenkymogram.

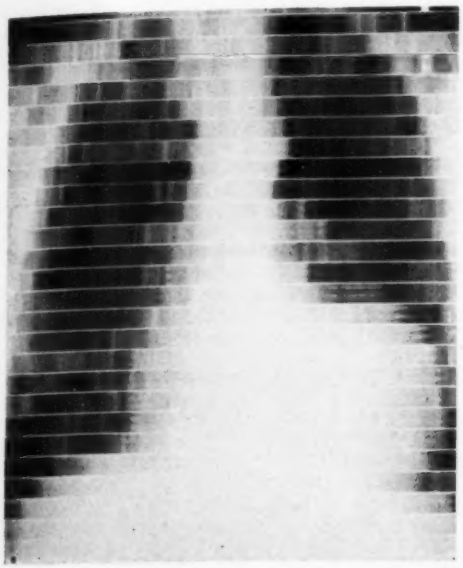
AK. Aortic knob. LLB. Lower left border. SVC. Superior vena cava. 1 and 2. Heart sounds. CP. Carotid pulse (only a portion of the tracing is recorded).

Electrokymography (Fig. 6) showed normal aortic and left lower border pulsations. The tracing from the border of the huge left atrium shows a complex form, with two systolic and one diastolic peak somewhat resembling the auricular curves often obtained from the right heart border. This curve is distinctly different from both the aortic and ventricular wave forms; the main systolic upward deflection may result from filling of the atrium during the regurgitation through the mitral valve.

C. *Tricuspid Regurgitation*

CASE VI: L. I., a 57-year-old male, was first seen as an outpatient, with ascites, dyspnea, and edema of the legs. The neck vessels pulsated and there were cardiac enlargement, a systolic thrill, and a rough systolic murmur. The cardiac rhythm was irregular (auricular fibrillation). The previous health had been good, and there was no history of rheumatic fever. Subsequently there were numerous hospital admissions for treatment of ascites and pernicious anemia. An exploratory laparotomy confirmed the preoperative diagnosis of portal hypertension; the pressure in the right gastro-epiploic vein was 30 cm. of water. There were no gross pathologic findings, and a liver biopsy showed only mild chronic hepatitis.

During two years of observation, collateral circulation developed on the abdominal wall, and systolic filling of the neck veins became more prominent, although no liver pulse was palpable. The electrocardiogram showed auricular fibrillation and left axis deviation.



Roentgenologically, the heart was found enlarged both to the right and left, with enlargement of both ventricles. Fluoroscopically, systolic outward movement of the superior vena cava was noted. The *roentgenkymogram* (Fig. 7) shows greatly increased amplitude of pulsations over both right and left heart borders, but the margin of the superior vena cava is indistinct, and the nature of its pulsation cannot be made out.

Venous catheterization of the right heart was carried out. Fluoroscopically, excessive pulsations of the catheter in the superior vena cava were apparent. The catheter coiled up in a greatly enlarged right atrium which extended well to the left of the midline. The catheter could not be introduced into the right ventricle, the tip apparently being deflected by the stream of blood regurgitating through the tricuspid orifice during systole.

Fig. 9. Case VII (left ventricular aneurysm). Aneurysm produces marked prominence of left lower pole of cardiac silhouette. Paradoxical movement of aneurysm border is not obvious but sustained outward position in systole can be recognized on careful comparison with aortic pulsations.

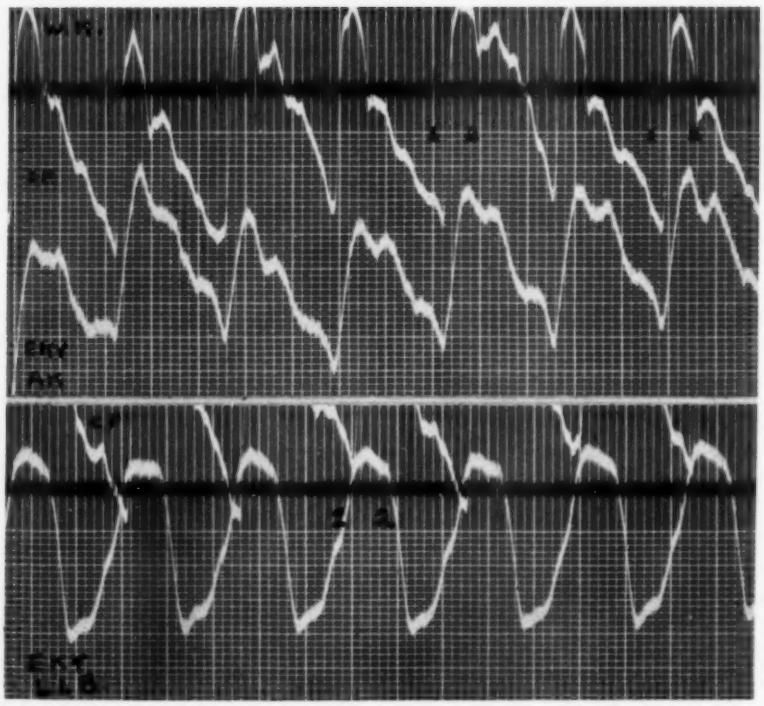


Fig. 10. Case VII. Electrokymogram of border of large ventricular aneurysm shows inward movement confined to early diastole (following second heart sound). Outward position of border is sustained paradoxically during systole (interval from 1st to 2nd heart sounds). Compare with normal ventricular curves (Figs. 1 and 2).

EKY. Electrokymogram. AK. Aortic knob. LLB. Lower left border (over ventricular aneurysm). CP. Carotid pulse. 1 and 2. Heart sounds.

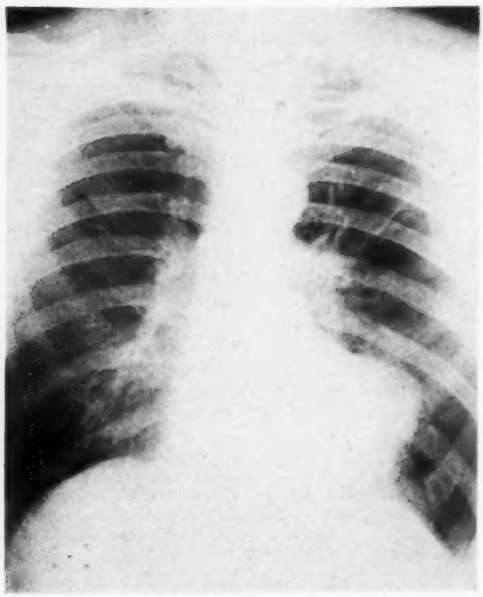


Fig. 11. Case VIII (left ventricular aneurysm). Somewhat angular localized protrusion from left heart border represents aneurysm which showed "paradoxical" pulsations fluoroscopically.

The *electrokymogram* (Fig. 8) shows the slow, totally irregular cardiac rhythm with greatly increased amplitude over all borders of the heart and great vessels. The systolic outward thrust of the superior vena cava, due to regurgitation from the right ventricle, is clearly shown. The unusually rapid diastolic outward movement over the left lower border is unexplained; there was no clinical evidence of aortic or mitral insufficiency which might have caused this phenomenon by abnormally rapid left ventricular filling.

D. Ventricular Aneurysm

CASE VII: W. K., a male 62 years of age, had been hospitalized one year during an episode of coronary occlusion, with severe chest pain radiating down both arms. The onset of dyspnea had occurred one month before. Thereafter dyspnea and angina on effort continued. The electrocardiogram six months after the acute attack showed right axis deviation with deep Q_1 and negative T_1; the interpretation was "myocardial damage—old anterior infarct."

Roentgenologically, evidence of a left ventricular aneurysm was first noted eight months after the first episode of coronary occlusion. A very large rounded mass occupied the left lower pole of the cardiac silhouette. Fluoroscopically, paradoxical pulsation over the ventricular aneurysm was apparent. In the *roentgenkymogram* (Fig. 9), this paradoxical movement is not obvious, but comparative analysis of the aortic and the left border waves shows that the outward position of the border of the aneurysm is maintained during systole. That this feature characterizes the movement of the border of the aneurysm is strikingly shown in the *electrokymogram* (Fig. 10). A plateau results, extending from the onset of systolic ejection to the end of systole, denoted by the second heart sound. Immediately thereafter, in early diastole, there is an abrupt inward movement followed by normal, more gradual outward movement persisting into the isometric phase of systole.

CASE VIII: A. K., a male 58 years of age, gave a history of the onset of exertional angina and dyspnea four years before. Examination at that time had disclosed electrocardiographic evidence of an anterior infarct of the left ventricle and the roentgen finding of a large aneurysm of the left ventricle. Electrocardiogram at the present examination showed left axis deviation, negative T_1, TCF_4, and TCF_6, low T_2; the interpretation was "pattern consistent with anterolateral infarct."

Roentgenologically, a somewhat angular protrusion from the left lower heart border was noted (Fig. 11). This showed "paradoxical" pulsations fluoroscopically, and its appearance was quite typical of left ventricular aneurysm of more localized character than in the preceding case. Figure 12 provides an interesting comparison of the *roentgenkymogram* and *electrokymogram* in this case. The latter shows, over the border of the aneurysm, the same features noted in the previous case, namely, sustained outward displacement in systole with very rapid early diastolic inward movement. Only one frame of the roentgenkymogram shows this characteristic; the two adjacent frames show rather nondescript appearances. The frames to the right show well the relationship between the movement of the aortic knob and that of the aneurysm. In this instance, both in the electrokymogram and roentgenkymogram, outward movement of the border of the aneurysm can be seen to continue into the early part of the phase of systolic ejection.

Comment: The records in these two cases of aneurysm of the left ventricle demonstrate the advantages of the electrokymographic method in the analysis of gross disturbances of ventricular activity. Marked variations may occur in the appearance of adjacent frames in the roentgenkymogram, without apparent reason. Electrokymograms, on the other hand, from several points on the borders of the aneurysms in these cases showed fundamentally similar features; this observation strongly suggests that marked variation between adjacent frames in the roentgen-

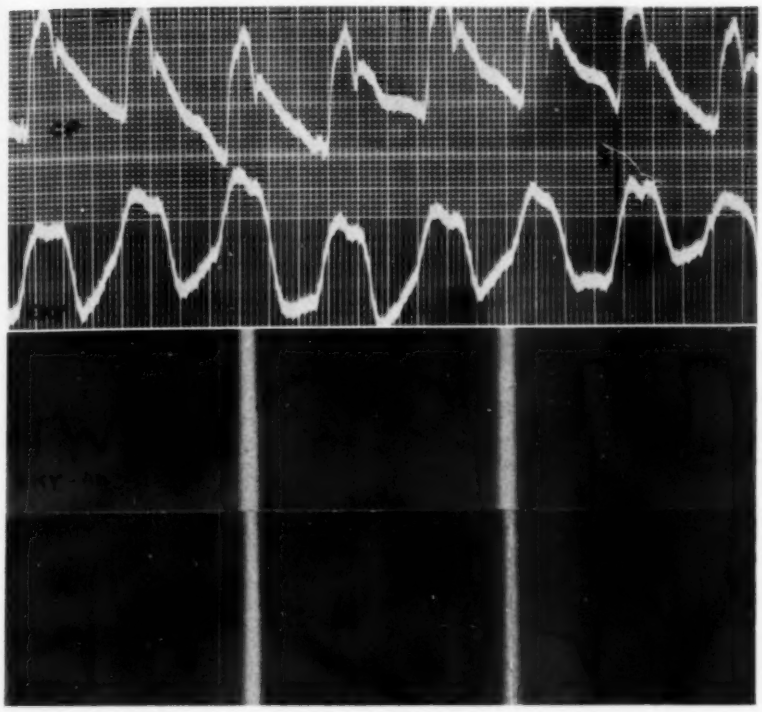


Fig. 12. Case VIII (left ventricular aneurysm). Electrokymogram and roentgenkymogram.

CP. Carotid pulse. EKY. Electrokymogram of aneurysm border in frontal view. RKY-An. Adjacent frames of roentgenkymogram over aneurysm border enlarged so that timing closely approximates that in electrokymogram (curves inked in because of low contrast on film). RKY-AK. Adjacent frames over aortic knob. S. Onset of systolic ejection.

kymogram often represents artefacts. Often these artefacts simulate standstill of the ventricular border.

Analysis of the electrokymographic curves from the borders of these two left ventricular aneurysms leads to the following interpretation. The most rapid outward movement of the aneurysm wall occurs during isometric contraction of the ventricle and early systolic ejection. During the latter part of systole the wall remains displaced outward, only to move abruptly inward shortly after closure of the semilunar valves, presumably as its blood content rushes into the relaxed remainder of the ventricle. The subsequent gradual outward movement of normal diastolic filling is interrupted by the outward thrust imparted by the isometric contraction of the healthy portion of the myocardium.

SUMMARY

The cases described provide illustrations of some of the possibilities of kymography of the heart and great vessels now that a practical method is available for record ng pulsations and correlating them with events in the cardiac cycle. The electrokymographic tracings from the aortic knob, pulmonic arc, and left ventricle are fundamentally the same as those of the roentgenkymogram; the arterial curves resemble experimental central arterial pressure curves, while the ventricular curves are surprisingly similar to experimental ventricular volume curves. The exact role of positional change of the heart as a whole in

producing these curves is not yet established, but the fact that densigrams of both the great vessels and the ventricle are similar to the border electrokymograms strongly suggests that actual volumetric changes are more important.

The aortic electrokymograms in three out of four cases of interatrial septal defect studied showed atypical features, perhaps related to altered hemodynamics or it may be to the effect of the adjacent greatly enlarged pulmonary artery. Studies of vascular pulsations in valvular lesions and intracardiac shunts may reveal characteristic features. One of these cases (Case IV) showed no density change over a huge right pulmonary artery branch, although there were ample border movements registered; this observation suggests thrombosis and is the finding that might be anticipated in connection with a non-vascular structure exhibiting transmitted motion.

An auricular-type wave was obtained from the border of a left atrium enlarging to the left, and in another case marked systolic pulsation of the superior vena cava due to tricuspid regurgitation was shown. With increased experience, it should be possible to recognize venous and auricular as well as arterial and ventricular pulsations and to utilize these to aid in identifying cardiac and mediastinal masses as well as in studying cardiac physiology.

Electrokymograms from left ventricular aneurysms in two cases studied showed sustained outward position in systole with abrupt inward movement in early diastole. Recognition of similar but less outspoken changes may prove of importance in localizing myocardial infarction in the absence of aneurysm of the ventricular wall. Chamberlain (4) has reported electrokymographic findings of this same general type in cases of myocardial infarction.

CONCLUSIONS

The electrokymograph is a valuable addition to the methods of study of normal and abnormal cardiovascular pulsations in the chest. In clarity, freedom from artefacts, and ease of correlation with events in the cardiac cycle, it is far superior to the roentgenkymogram. However, the roentgenkymogram provides on a single film considerable information relative to amplitude of pulsations. Use of both methods in a group of clinical cases has shown that they may be regarded as supplementary, the electrokymogram filling in the finer details which are lacking in the roentgenkymogram.

University Hospital
Minneapolis 14, Minn.

BIBLIOGRAPHY

1. BATT, R. C.: A Roentgenkymographic Study of the Heart in Myasthenia Gravis. Radiology **48:** 374–380, April 1947.

2. BOONE, B. R., CHAMBERLAIN, W. E., GILLICK, F. G., HENNY, G. C., AND OPPENHEIMER, M. J.: Interpreting the Electrokymogram of Heart and Great Vessel Motion. Am. Heart J. **34:** 560–568, October 1947.

3. CHAMBERLAIN, W. E., BOONE, B. R., ELLINGER, G. F., HENNY, G. C., AND OPPENHEIMER, M. J.: Asynchronism of Ejection of the Ventricles as Measured with the Electrokymogram. Federation Proc. **6:** 88, March 1947.

4. CHAMBERLAIN, W. E.: Roentgen Electrokymography. Acta radiol. **28:** 847–858, Nov. 13, 1947.

5. CHAVEZ, I., DORBECKER, N., AND CELIS, A.: Direct Intracardiac Angiocardiography; Its Diagnostic Value. Am. Heart J. **33:** 560–593, May 1947.

6. GRISHMAN, A., SUSSMAN, M. L., AND STEINBERG, M. F.: Angiocardiographic Analysis of the Cardiac Configuration in Rheumatic Mitral Disease. Am. J. Roentgenol. **51:** 33–43, January 1944.

7. HECKMANN, K.: Moderne Methoden zur Untersuchung der Herzpulsation mittels Röntgenstrahlen. Ergebn. d. inn. Med. u. Kinderh. **52:** 569–610, 1937.

8. HENNY, G. C., AND BOONE, B. R.: Electrokymograph for Recording Heart Motion Utilizing the Roentgenoscope. Am. J. Roentgenol. **54:** 217–229, September 1945.

9. HENNY, G. C., BOONE, B. R., AND CHAMBERLAIN, W. E.: Electrokymograph for Recording Heart Motion: Improved Type. Am. J. Roentgenol. **57:** 409–416, April 1947.

10. HJELMARE, G.: Registration of Movements of the Heart with Geiger-Müller Counters and Synchronous Electrocardiography. Acta radiol. **27:** 334–338, May 6, 1946.

11. HIRSCH, I. S., AND GUBNER, R.: Application of Roentgenkymography to the Study of Normal and Abnormal Cardiac Physiology. Am. Heart J. **12:** 413–434, October 1936.

12. JACOBI, J., JANKER, R., AND SCHMITZ, W.: Kombination röntgenkinematographischer, ionometrischer, und electrokardiographischer Untersuchungen. Deutsches Arch. f. klin. Med. **172:** 493–496, 1932.

13. JOHNSON, V., HAMILTON, W. F., KATZ, L. N., AND WEINSTEIN, W.: Studies on the Dynamics of the Pulmonary Circulation. Am. J. Physiol. **120:** 624–634, November 1937.

14. LIAN, C., AND MINOT, G.: La radioélectrokymographie. Arch. d. mal du coeur **39:** 339–345, October 1946.

15. MARCHAL, M.: De l'enregistrement des pulsations invisibles du parenchyme pulmonaire ainsi que

des pulsations cardio-vasculaires par la kine-densigraphie. Arch. d. mal du coeur **39:** 345–359, 1946.

16. ROESLER, H.: Clinical Roentgenology of the Cardiovascular System. Springfield, Ill., Charles C Thomas, 2d ed., 1943.

17. SCHWARZCHILD, M. M.: Physical Principles of Slit Kymography. Radiology **33:** 90–107, July 1939.

18. STAUFFER, H. M.: Electrokymography. Staff Meeting Bulletin, Hospitals of the University of Minnesota **18:** 462–473, May 1947.

19. STUMPF, P., WEBER, H. H., AND WELTZ, G. A.: Röntgenkymographische Bewegungslehre innerer Organe. Leipzig, Georg Thieme, 1936.

20. WIGGERS, C. J.: Physiology in Health and Disease. Philadelphia, Penna., Lea & Febiger, 3d ed., 1939.

21. ZDANSKY, E., AND ELLINGER, E.: Röntgenkymographische Untersuchungen am Herzen. Fortschr. a. d. Geb. d. Röntgenstrahlen **47:** 648–661, June 1933.

SUMARIO

Electroquimografía del Corazón y de los Grandes Vasos; Correlación con la Roentgenoquimografía en los Estudios Clínicos

La electroquimografía constituye una valiosa adición a los métodos de estudio de las pulsaciones cardiovasculares, normales y anormales, en el tórax, superando con mucho la roentgenoquimografía en lo relativo a claridad, ausencia de artefactos y fácil correlación con los fenómenos del ciclo cardíaco. El roentgenoquimograma ofrece, sin embargo, en una sola película considerable información acerca de la amplitud de las pulsaciones. El empleo de ambas técnicas en un grupo de casos ha revelado que pueden considerarse como complementarias, aportando la electroquimografía los detalles más delicados que faltan en la roentgenoquimografía.

Los trazados electroquimográficos del cayado de la aorta, el arco pulmonar y el ventrículo izquierdo son fundamentalmente idénticos a los roentgenoquimográficos; las curvas arteriales semejan las de la presión arterial central obtenidas experimentalmente, en tanto que las ventriculares sorprenden por su semejanza a las curvas del volumen ventricular experimental.

En 3 de 4 casos de defectuosidad del tabique interauricular, el electroquimograma reveló características atípicas, quizás relacionadas con la alterada hemodinámica o con el efecto de la gran hiperplasia de la adyacente arteria pulmonar. Los estudios de las pulsaciones vasculares en las lesiones valvulares y las desviaciones intracardíacas pueden revelar características propias. Un caso no reveló alteración de la densidad sobre una enorme rama de la arteria pulmonar derecha, aunque registrando amplios movimientos marginales, observación esta indicativa de trombosis y siendo el hallazgo que cabe esperar en relación con un tejido no vascular que manifiesta movimiento trasmitido.

Obtúvose una onda de tipo auricular del borde de una aurícula izquierda hipertrofiada hacia dicho lado, y otro caso mostró decidida pulsación sistólica de la cava superior, debida a insuficiencia de la tricúspide. Dos casos de aneurisma ventricular izquierdo revelaron posición exterior sostenida en la sístole, con brusco movimiento hacia adentro en los comienzos de la diástole.

En estos estudios empleóse el electroquimógrafo perfeccionado de Henny y Boone.

Evaluation of Needle Aspiration Technic in Breast Lesions[1]

JOHN W. BUDD, M.D.

Los Angeles, Calif.

AFTER DISCOVERY of a "true lump" in the breast, no amount of further clinical study will determine its nature. The only safe rule which may be followed is to prove the nature of every single lump. In certain groups of cases the use of needle biopsy does not contradict this premise and definitive information may be obtained before surgery is undertaken or when surgical treatment is not indicated. Three different types of procedure are employed in lesions of the breast: (1) aspiration of fluid from cystic lesions; (2) needling solid tumors while applying suction from a syringe to aspirate cells which may be smeared and stained; (3) removal of a solid core of tumor which is adequate for paraffin sections. The indications for these biopsy procedures are dependent upon the nature of the problem presented and are discussed in the following groups of breast tumors.

Lesions Presumed Clinically to Be Cancer: The breast tumor in many instances is fairly typical of cancer. Almost half of the cancers seen in office practice are too advanced to be considered operable, or the patients refuse surgery or have some disability contraindicating surgery. The patients in this group who receive palliative irradiation are candidates for needle biopsy diagnosis. In the remaining operable group, about one third are clinical Stage I cases. It is uniformly agreed that for these the treatment is radical surgery, and an incisional biopsy just prior to mastectomy has become the accepted method of confirming the diagnosis. Previous needle biopsy in the office is difficult to justify when adequate facilities for frozen sections are available at the time of surgery. The incisional biopsy is similarly the method of choice in clinical Stage II cancer of the breast treated by radical surgery without preoperative irradiation. In any Stage II cases receiving preoperative irradiation, however, histologic confirmation by needle biopsy is indicated.

When an incisional biopsy is made, the surgeon removes a wedge of tissue, or the entire tumor, depending upon its size and location, to provide the material which will be most representative of the disease. The danger of disseminating tumor cells or seeding the wound should be minimal with proper technic. Although this preliminary step is time-consuming and requires redraping of the wound, etc., any short cuts to diagnosis in place of this routine gross and microscopic study result in too frequent errors.

The needle biopsy, limited to the larger and more obvious cancers, is a very simple procedure and should yield a high percentage of positive results. In small tumors it is less often successful and probably should not be attempted in lesions measuring less than one centimeter. Enlarged nodes may prove to be a better biopsy site. The operation may be done with a minimal amount of trauma if well sharpened needles are used, and rough handling and multiple stabs into the tumor are unnecessary. In the usual firm cancer the Silverman needle is the most successful in cutting a small cylinder of tissue from which smears and paraffin sections can be made. Local anesthesia of the skin only is followed by a nick through the skin large enough to admit the needle into the breast tissue. The point of the sheath is introduced until it reaches the periphery of the tumor, and the inner split portion is then pushed forward to engage a section of tissue between the blades. The core is cut away by rotating the outer shell while it is moved

[1] From the Los Angeles Tumor Institute. Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

downward to ensheath the exposed segment of the inner needle with the specimen. The entire instrument is then withdrawn and the cylindrical core is removed from the end of the needle on the knife point. In soft mucoid or medullary tumors, adequate tissue can be aspirated directly into the needle by using an attached syringe. The high percentage of instances in which material that is adequate for a reliable study can be removed with needle biopsy should eliminate any need for basing irradiation for breast cancer on clinical study alone.

Cysts of the Breast: Cystic lesions of the breast often present a typical history and appearance. Any localized "lump" which is presumed clinically to contain fluid may be explored with a 26-gauge needle without danger or undue discomfort to the patient. Decompression of a cyst, with complete disappearance of all palpable swelling, would seem to fulfill the original premise that the presence of a breast tumor demands proof of its nature. There is a great deal of objection, however, to conservative aspiration treatment of breast cysts, because a small percentage are associated with a papillary growth which may become malignant. It is also possible that a cyst may rarely mask a small cancer that would be missed if the lesion were not explored. Although the single or multiple blue-domed cyst is not regarded in itself as being any more precancerous than the normal breast and can be cured in a high percentage of instances by aspiration, this method should not be employed unless careful follow-up examination will be possible to insure the benign nature of the cyst. It is the opinion of many surgeons that, since the profession and laity have been taught to regard any breast tumor as indication for exploration, it would be dangerous to depart from this premise in the case of the cyst.

Clinical Problem Cases: A large group of patients present a "lump" in the breast, the clinical features of which are inconclusive. This group includes the lesions of benign adenosis and hyperplasia, as well as the early and much more favorable stages of malignant growth. Although it is technically possible to remove a sample of tissue with the biopsy needle in these diagnostic problem cases, the procedure is contraindicated for several reasons: (*a*) A negative report is without significance, since a small tumor is too easily missed. (*b*) Examination of the entire palpable area is the only sure method of excluding the diagnosis of cancer, and this amount of tissue must be provided by excisional biopsy. (*c*) Recognition of early cancer requires more adequate histologic preparations than are possible with needle biopsy methods. (*d*) The excisional biopsy completes the treatment if the process is proved to be benign.

These facts would indicate that there is no place for the needle biopsy in the diagnostic problem cases, and exploration of every solid lump is essential if cancer is to be discovered and treated in a curable stage.

SUMMARY

1. The presence of any "true tumor" in the breast demands proof of its nature.

2. The microscopic diagnosis of cancer should be established in every patient receiving irradiation therapy. This provides the greatest field for needle biopsy.

3. Operable breast cancer should be diagnosed by gross examination, with frozen-section study of incised or excised tumors during surgery. There is no indication in this group for needle biopsy methods.

4. Breast cysts may be diagnosed and treated by needle aspiration, but there are good reasons for favoring surgical excision over decompression.

5. Excision of the palpable lump in the diagnostic problem case is necessary to provide adequate material to exclude cancer and to detect the early stages of cancer. In this instance needle biopsies are contraindicated.

1407 S. Hope St.
Los Angeles 15, Calif.

SUMARIO

Valuación de la Técnica de la Aspiración con la Aguja en las Lesiones Mamarias

La presencia de cualquier tumor mamario impone la comprobación de su naturaleza. La principal indicación de la aguja en la biopsia radica en las lesiones que van a ser sometidas a la irradiación, ya paliativa o preoperatoria. En todos esos casos debe establecerse definitivamente el diagnóstico microscópico de cáncer. La biopsia con la aguja rinde, con un traumatismo mínimo, un alto porcentaje de resultados positivos en las lesiones mayores (más de 1 cm. de diámetro).

Los tumores mamarios operables no ofrecen indicación para la biopsia con la aguja, y deben ser diagnosticados por el examen macroscópico, con el estudio de cortes congelados durante la intervención cruenta. Los quistes de la mama pueden ser diagnosticados y tratados por la aspiración con la aguja, pero existen buenas razones en favor de la excisión quirúrgica en este grupo. En el caso de los bultos palpables que plantean un problema de diagnóstico, resulta indispensable contar con material adecuado para excluir el cáncer o para descubrirlo en sus etapas incipientes. Las biopsias con la aguja no se prestan para este fin.

DISCUSSION

Justin J. Stein, M.D. (Los Angeles): Dr. Budd has made a cautious report on a very controversial subject. If his criteria for the selection of cases for needle biopsy are carefully observed, then most of the controversial issues are eliminated.

Since from 2 to 4 per cent of adult women in this country have cancer of the breast, and since the over-all cure rate is only approximately 40 per cent, it is imperative that we utilize every means at our disposal for early diagnosis.

In our own series of cases of breast cancer, for each 100 cases seen, 50 per cent will be inoperable or beyond Stage II; of the remaining 50 per cent, 25 per cent will be obviously of clinical Stage II. Of the remaining 25 per cent, which are considered to be Stage I prior to surgery, slightly less than 40 per cent will be found pathologically to be of Stage II after histologic study of the axillary lymph nodes. An additional 10 per cent of the cases considered to be strictly of Stage I would also be pathologically of Stage II if thorough histologic studies were made of every lymph node removed at the time of radical mastectomy. In other words, we are fortunate if, out of each 100 consecutive admissions for cancer of the breast, there are 15 strictly Stage I lesions. The above observations also account for the fact that only 75 to 80 per cent five-year survivals without clinical symptoms are obtained in Stage I lesions following radical mastectomy.

For the Stage II cases, in which there is a lesion in the breast plus regional lymph node involvement, either a needle biopsy or incisional biopsy should be done if preoperative irradiation therapy is to be given. No cancer of the breast should be treated either for palliation or cure without a routine biopsy.

I prefer needle biopsy because it can be done immediately in the office; there is rarely any objection by the patient; there is very little discomfort or pain from the procedure, and irradiation therapy can be started immediately afterward. Many patients will either delay or postpone surgery if an incisional biopsy is recommended. Preoperative rather than postoperative irradiation is recommended for all Stage II lesions because with preoperative irradiation we obtain approximately 17 per cent better five-year results. A thorough course of irradiation therapy is given to the breast and the regional lymphatics, followed in six to eight weeks by radical mastectomy.

For the definitely inoperable cases of cancer of the breast, needle biopsy is preferred over incisional biopsy as long as the biopsy specimen is adequate. If it is not adequate for diagnosis, then an incisional type of biopsy is done.

A needle biopsy or aspiration of a cyst should not be done unless the individual performing this procedure is capable of making a histologic diagnosis on the tissue removed or on the cellular sediment when fluid is removed. A negative biopsy report is not to be considered conclusive.

As to lumps not obviously malignant in the breasts of adult women, one can almost guess that half of them will prove to be malignant, but this cannot be determined without histologic examination. In other words, it is frequently very difficult to tell from a clinical standpoint whether or not a lesion of the breast is malignant. In these cases needle biopsy or aspiration is of great help. As Dr. Budd pointed out, if fluid is obtained and the fluid or sediment contains no malignant cells and the cyst completely disappears without any residual lump or swelling, it is then believed that the

lesion is benign in character, though the patient should be examined at frequent intervals. Rarely a cancer begins in a cyst wall or in immediate association with a cyst. Examination of the sediment from the fluid of such a cyst will reveal malignant cells, or the cyst may promptly refill and require further investigation. If malignant cells are found, radical surgery is recommended. If a palpable mass remains after aspiration of the cyst, excision of the involved area should be done in the operating room, with a pathologist present.

I personally like the needle biopsy method even for solitary lesions in the breast, since, if malignant cells are found, a radical mastectomy can be done without having to remove the lesion for pathologic examination. If the pathologist finds the incisional biopsy specimen to be malignant, then the operative wound has to be closed, the tumor bed has been disturbed, the operative field has to be resterilized and redraped, and the operators regowned, all of which takes from twenty to thirty minutes. If an adequate and conclusive needle biopsy can be obtained prior to surgery, one-half hour of surgery is eliminated, the tumor bed is not disturbed, and perhaps the patient is operated upon more promptly. Also a diagnosis may be made by this method, whereas scheduling the patient for an incisional biopsy may cause needless delay because of fear, failure on the part of the patient to make up her mind, or other reasons.

Several recent investigations have shown that approximately 30 per cent of the delay in patients having cancer of the breast is attributable to bad medical advice by physicians. Surely we as physicians can eliminate this factor by not guessing but rather making definite diagnoses when confronted with a questionable lesion.

(*For further Discussion see page 518*)

Value and Limitations of Aspiration Biopsy for Lung Lesions[1]

GEORGE P. ROSEMOND, M.D., W. EMORY BURNETT, M.D., and JOHN H. HALL, M.D.
Philadelphia, Penna.

WE HAVE BEEN convinced of the value of needle biopsy in diagnosing malignant lesions of the lung since shortly after we first started using it in 1936. From 1936 to 1947 inclusive, we performed biopsies by this method in approximately 272 lesions of the lung, in 231 patients. It was necessary to repeat the procedure in a number of patients, and on numerous occasions we were unable to made a diagnosis. We were greatly encouraged by the excellent reports of Craver (1, 2) from Memorial Hospital, which appeared in 1939 and 1940. Memorial Hospital diagnosticians are still enthusiastic about this procedure. Others, however, including Ochsner (3) and Holman (4), who are experienced in diagnosing and operating on patients with carcinoma of the lung, have been strongly opposed to what we have come to consider a very useful method of diagnosis.

We do not contend that all patients who are suspected of having pulmonary carcinoma should have needle biopsy. We much prefer, in fact we insist, that needle biopsy be preceded by an attempt at bronchoscopic biopsy. In our own hospital, the Jackson Clinic has been able to make a positive diagnosis in about 70 per cent of the patients who have been proved to have carcinoma of the lung (5). Bronchoscopic biopsy should be attempted in all cases, even though the lesion appears on x-ray examination to be located peripherally, since the peripheral lesion may possibly be a secondary manifestation of a primary neoplasm of a large bronchus. We also believe that, should pathologic analysis of secretions obtained by bronchoscopy prove as successful as the early reports indicate, needle biopsy should be done only when a conclusive diagnosis cannot be made in that way. We have reserved needle biopsy for patients who present a lesion which can be demonstrated by fluoroscopy and which cannot be successfully biopsied by bronchoscopy. So far we have only experimented with sputum examination. We are convinced that it is advantageous to have a positive diagnosis when possible before exploration is attempted. At operation it is often difficult, if the lesion is deeply situated, to obtain a specimen which may be examined by frozen-section microscopy, and a gross diagnosis is often inaccurate.

It is not the purpose of this paper to attempt to sell needle biopsy to anyone. We would like merely to present the method and the dangers of needle biopsy of the lung, and to analyze statistically our own experience with this procedure. We have become convinced that, although it involves some hazards, needle biopsy performed with care and with the proper appreciation of the difficulties which may be encountered is a useful and safe method. It is of value especially in the peripheral, circumscribed lesions which are not usually accessible to bronchoscopy. Only a definite positive diagnosis should be accepted. We long ago learned to disregard a negative diagnosis, and when this is obtained, we proceed with other methods. We believe it is useless and dangerous to attempt needle biopsy without a biplane or multiplane fluoroscope and a competent fluoroscopist to aid in guiding the needle to the proper site. Also, a competent pathologist, one who is accustomed to making a diagnosis on small specimens, must be available.

The chief contraindication which has been presented to needle biopsy in operable lesions is the risk of spread along the

[1] From Temple University Hospital, Philadelphia, Penna. Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

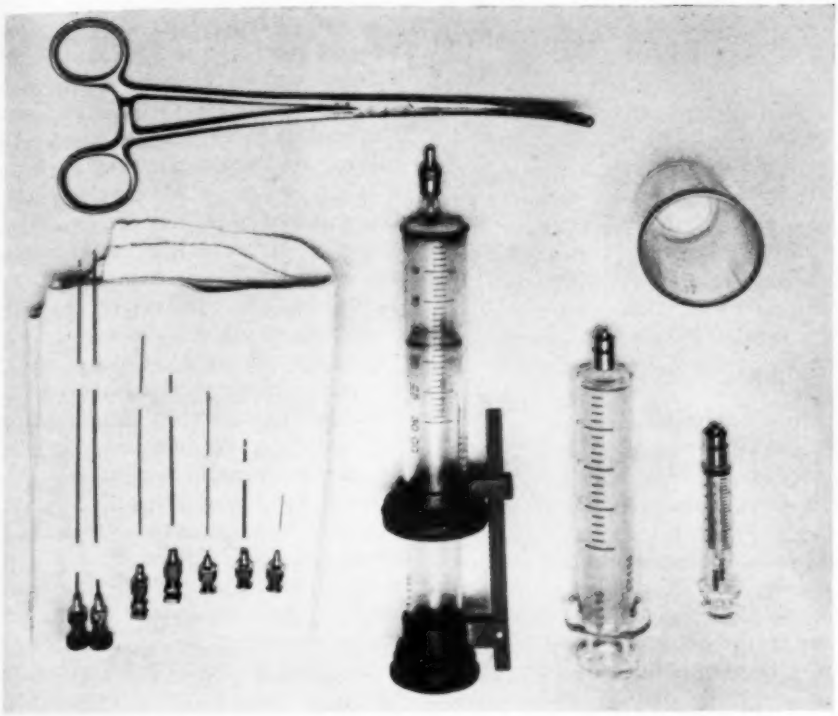


Fig. 1. Equipment used in the performance of needle biopsy in pulmonary lesions.

needle track. We have attempted for years to find definite evidence of such spread and have never seen an instance in our own experience. For a long time we, too, avoided needle diagnosis on operable cases, but failing to find evidence of spread, we have used this method for diagnostic purposes on tumors of all types, both operable and inoperable.

We have recently followed 67 patients on whom pneumonectomy has been performed during the past twelve years. In 19 of these patients, the diagnosis was made by needle biopsy. Eight of the 19 are still living from five months to four years after operation. In none of the 11 who have died could evidence of spread along the needle track be determined when they succumbed to the carcinoma. The majority of these patients died with distant metastases. One man lived two years and died of tumor of the brain, which was thought to be metastatic from a different and subsequent adrenal carcinoma.

Another supposed hazard, which we have not encountered, is empyema.

The most common hazard in our experience has been pneumothorax. This accounted for one death and another almost fatal complication. Both these patients presented x-ray evidence of advanced emphysema. Pneumothorax has occurred, however, when emphysema was not suspected roentgenographically. For the most part, such pneumothorax has been without serious symptoms.

Hemorrhage into the lung parenchyma from traversing pulmonary vessels has not occurred, although one person did die of shock and convulsions shortly after the procedure was begun. At autopsy this patient showed no local pulmonary hemorrhage, and no definite cause of death was found. Unfortunately, postmortem brain examination was not done. Intravascular spread to the brain has not been a factor.

Fig. 2. Circumscribed peripheral carcinoma of the lung diagnosed by needle biopsy.

The possibility of septic cerebral air embolism in the above case must be kept in mind. One patient died twenty-four hours after needle biopsy, and coronary thrombosis was proved at autopsy. In another a central type of facial palsy developing seven days following the procedure proved to be due to a cerebral metastasis. It is possible this may have originated from the aspiration biopsy, but the time element makes it most unlikely.

For accurate localization, the lesion must be definitely visible in at least two planes, making a biplane or multiplane fluoroscope essential. We have obtained positive biopsies by aiming at the apex of an atelectatic area of lung, and we often attempt biopsy under these circumstances, although our failures have been in this particular group of patients. We have rarely failed to obtain a positive diagnosis on biopsy of a peripheral circumscribed lesion (Fig. 2). We have on occasion obtained necrotic material from the center of a rapidly growing carcinoma. To avoid this difficulty, an attempt is made to obtain one specimen from the center of the lesion and another from the periphery.

The technic is relatively simple. The necessary equipment includes one 3-inch and two 6-inch 18-gauge needles with a well fitting stilet, a 30-c.c. syringe fitted with a ratchet lock to insure a partial vacuum in the syringe, local anesthesia, material for preparing the skin, sterile rubber gloves, drapes, and normal saline solution (Fig. 1). We have recently adopted a modified "Franceen" needle. The majority of lesions are located about the middle of the thorax near the hilus. It is best to have the patient lying on his back and to approach the lesion anteriorly, providing the distance is not too great, since the angle of the ribs makes introduction into the thorax simpler from this direction. We generally introduce the needle from either the front or the back so that the point is away from the mediastinum. The skin, of course, must be prepared as for any thoracentesis. The center of the mass is marked with the vertical x-ray beam, and, with a long hemostat, a skin wheal is raised over this spot. A needle hole is made through the skin before introducing the biopsy needle, to eliminate the possibility of picking up confusing skin fragments with the biopsy. The 18-gauge needle of proper length with the stilet firmly in place is directed toward the mass. Vertical and horizontal fluoroscopic checkups are obtained after the tip of the needle is presumed to be near the lesion, and from time to time the position of the point of the needle is checked. Not until the tip of the needle is in the mass is the stilet removed, thus minimizing the chance of pneumothorax. Following removal of the stilet, the lock syringe is placed on the needle, suction is applied, and the syringe is locked. The syringe should contain 3 to 4 c.c. of normal saline solution, so that the particles obtained will float in it. A few short jabs are then made with the needle and it is withdrawn, negative pressure being maintained in the syringe until withdrawal of the needle is complete. After withdrawal, the biopsy material will be drawn into the syringe and will float in the normal saline solution. Following evacuation of this material into a test tube, the syringe and the needle are thoroughly

cleansed with saline so that any retained particles are deposited in the test tube. The tiny specimen should be grossly viewed with the naked eye. If a copious quantity of material is obtained, it is assumed that the center of the tumor is necrotic, and the procedure is repeated at the periphery. We routinely send a specimen of material for bacteriologic study as well as for pathologic study, and occasionally we have obtained interesting bacteriologic information.

Using the above procedure, we have performed 272 needle biopsies on 231 patients during the years 1936 through 1947, as previously stated. Two hundred and twenty of the patients were suspected of having bronchogenic carcinoma, not accessible to bronchoscopy and not proved by sputum examination. In 11 patients biopsy was done for other suspected intrathoracic lesions, but lung tissue was traversed. Of the 220 patients, 163 were proved to have carcinoma of the lung by a definite pathologic report on material obtained by needle biopsy, by subsequent bronchoscopic biopsy, or by exploratory thoracotomy, which was utilized as the final resort; 135 were proved to have pulmonary carcinoma by needle biopsy. Not included in the latter figure are 18 cases with a questionable positive diagnosis of pulmonary carcinoma, as we do not accept a questionable positive diagnosis. The positive diagnosis rate was therefore approximately 61 per cent, which is comparable to Craver's 51.6 per cent for 1935 to 1939 (2). Among our diagnoses there was one false positive. A lymphoblastoma was diagnosed as carcinoma. Operation led to a correct diagnosis, and the patient subsequently received x-ray therapy. Incidentally, we are usually unable to make a positive diagnosis of lymphoblastoma by needle biopsy, since the tumor is so dense that we cannot obtain a suitable specimen. This has been our only instance of false diagnosis when lymphoblastoma was needled.

A critical analysis of the complications associated with this procedure shows us to have had 20 so-called complicated cases, representing 7.35 per cent of the needle biopsies done. Three patients died rather shortly after the procedure. One died within twenty-four hours, from shock and convulsions, for which no definite cause was found at autopsy. In another who died suddenly about twenty-four hours after aspiration, autopsy showed the death to be a cardiac one, which could hardly be blamed on the procedure. Another died of a tension pneumothorax, which developed shortly after needle biopsy and was treated by aspiration. We have had no serious complications since December 1945. There have been only two serious pneumothoraces; one occurred in a patient who had had a previous pneumonectomy. This was our most foolish error, and at present previous pneumonectomy is considered a positive contraindication to aspiration biopsy, since pneumothorax can be so serious when the opposite lung is absent. Both patients with serious pneumothorax had evidences of marked emphysema, which mades the procedure hazardous. There were eight other non-symptomatic pneumothoraces. Seven patients had fever and chills, which were not serious and which disappeared in twenty-four hours. One patient, already referred to, showed a central facial palsy seven days following the procedure and died later of metastatic tumor. We had no idea whether the needle biopsy contributed to the spread into the blood stream.

COMMENT

We have been quite impressed with the efficacy of needle aspiration for obtaining a tissue diagnosis of carcinoma of the lung when bronchoscopic visualization of the tumor is not possible. It has been our custom to utilize this method without a previous narcotic, and the patient often walks back to his room.

The procedure is a simple one and should be used when a definite diagnosis of carcinoma cannot be made by bronchoscopy or by sputum analysis. Although it is not entirely safe, the hazards can be minimized

if certain precautions are observed. We have not had a serious pneumothorax in any patient who did not previously show x-ray evidence of marked pulmonary emphysema. We have seen no empyema develop as the result of traversing infected lung, although we have never utilized this procedure when a pneumothorax was present or when the layers of visceral and parietal pleura were not in apposition. We have seen no evidence that tumor is spread along the needle track on withdrawal of the needle.

The method is especially efficacious in peripheral lesions. Although a tissue diagnosis cannot be obtained when calcification is present in a peripheral nodule, the nodule can be moved visibly and calcification palpated with the needle so that a diagnosis can at least be suspected in such cases. The method lends itself especially well to soft carcinomas peripherally located in the lung. We have had little success in diagnosing firm, solid, benign lesions or lymphoblastomas. Our success has been limited also when we have attempted to diagnose lesions which cannot be definitely visualized and when we have aimed solely at the base of an atelectatic area. The method is relatively useless unless a biplane or multiplane fluoroscope, a competent fluoroscopist, and a pathologist who will make a diagnosis from a very small specimen are available.

SUMMARY

A method of needle biopsy of pulmonary tumors has been discussed. We have come to accept this method as a valuable aid in the diagnosis of carcinoma of the lung. Our experience in 272 procedures over a twelve-year period has shown us that, although the method has some hazards, it is relatively safe.[2] We are thoroughly convinced that the danger of spread of the tumor along the needle track, which has been presented by many as a definite contraindication to needle biopsy in operable pulmonary lesions, has been overemphasized.

3401 North Broad St.
Philadelphia 40, Penna.

REFERENCES

1. CRAVER, L. F., AND BINKLEY, J. S.: Aspiration Biopsy of Tumors of the Lung. J. Thoracic Surg. 8: 436–463, April 1939.
2. CRAVER, L. F.: Diagnosis of Malignant Lung Tumors by Aspiration Biopsy and by Sputum Examination. Surgery 8: 947–960, December 1940.
3. OCHSNER, A., DEBAKEY, M., AND DIXON, J. L.: Primary Cancer of the Lung. J. A. M. A. 135: 321–327, Oct. 11, 1947.
4. HOLMAN, E.: Personal communication.
5. NORRIS, C. M.: Early Clinical Features of Bronchogenic Carcinoma. Dis. of Chest 14: 198–217, March-April, 1948.

[2] Since this material was accumulated, we have done over 30 additional needle biopsies with no complications.

SUMARIO

Valor y Limitaciones de la Biopsia Aspiratoria en las Lesiones Pulmonares

Los AA. han ejecutado biopsias con la aguja en 272 lesiones pulmonares en 231 enfermos, considerando el método como auxiliar valioso para el diagnóstico del carcinoma, aunque creyendo que, en todos los casos, debe probarse primero la biopsia broncoscópica. La técnica de la aguja posee valor en particular en las lesiones periféricas circunscritas que no suelen ser accesibles al broncoscopio. Con este método únicamente un diagnóstico positivo resulta aceptable; los hallazgos negativos no son terminantes.

Para la localización de la lesión se necesita un fluoroscopio biplano o poliplano, y hay que contar con un fluoroscopista competente para guiar la aguja al sitio procedente. Un patólogo acostumbrado a hacer el diagnóstico en ejemplares pequeños resulta indispensable. Si bien el procedimiento encierra algún riesgo, es relativamente inocuo. Los AA. se sienten convencidos que se ha exagerado el peligro de la propagación del tumor por la senda seguida por la aguja, pues jamás han encontrado tal complicación.

Diagnosis of Bronchogenic Carcinoma by Cytologic Methods[1]

SEYMOUR M. FARBER, M.D., F.C.C.P., MORTIMER A. BENIOFF, M.D., and ALLEN K. McGRATH, JR., M.D.

San Francisco, Calif.

ATTENTION HAS been focused recently upon the application of cytologic technics to the diagnosis of primary carcinoma of the lung. Experience with 100 cases of proved bronchogenic carcinoma has indicated that this technic has diagnostic value. The need for additional diagnostic aids in this disease has been emphasized in reported series (1, 2, 3, 4, 5) in which as high as 50 per cent of the cases were not recognized prior to autopsy.

As early as 1887 Hampeln was able to diagnose carcinoma of the lung by examination of unstained microscopic particles of expectorated malignant tissue. Other early workers also reported the diagnosis of cancer of the lung by finding bizarre cells in sputum examined by such simple methods. More recent investigators have blocked and sectioned sputum, using ordinary histologic technics, and some have reported good results (6, 7). The development of wet-film technics has simplified the cytologic study of sputum and bronchial secretions and has led to more widespread use of this diagnostic procedure. In 1935 Dudgeon and Wrigley (8) described their wet-film technic for the diagnosis of malignant disease of the lung. In 1944 Wandall (9) of Denmark reported the use of this method with excellent results. He found malignant cells in 84 of 100 cases of proved bronchogenic carcinoma. The work of Papanicolaou and Traut (10), in 1943, on the diagnosis of uterine cancer by vaginal smears stimulated the application of the Papanicolaou technic to material exfoliated from other accessible tracts (11). Herbut and Clerf (12) in 1946 presented their experiences with this technic applied to bronchial secretions. These workers were able to make an accurate diagnosis in 47 of 57 cases (82 per cent) of carcinoma of the lung. Reports of successful application of the Papanicolaou method to sputum and bronchial secretions continue to appear in the current literature (13, 14, 15).

For the past two years we have been studying and evaluating the Papanicolaou method as applied to sputum and bronchial secretions (16, 17). This paper deals briefly with this study, the methods used and results obtained, and presents illustrative case histories. The material was obtained from university hospitals, general private hospitals, tuberculosis sanitariums, and private physicians. The patients were not in special cancer hospitals but either were suspected of having carcinoma of the lung or had an undiagnosed chest disease. Many specimens were received by mail from institutions and communities where adequate diagnostic facilities were not available.

Sputum was obtained by deep coughing and bronchial secretions by aspiration from suspected areas of the bronchial tree. The preparation of smears for examination has been described in detail in a previous publication (17). After the smears were stained, every field on every slide was carefully screened by trained technicians. Unusual cells were marked and examined by physicians experienced in cytologic diagnosis. These physicians had no knowledge of the clinical information on the patient. It was found necessary to examine at least three slides from each of five daily specimens before the cytologic examination could be considered adequate.

Criteria for identification of exfoliated malignant cells were developed by comparing direct smears of normal tissue, direct smears of tumor tissue, and histo-

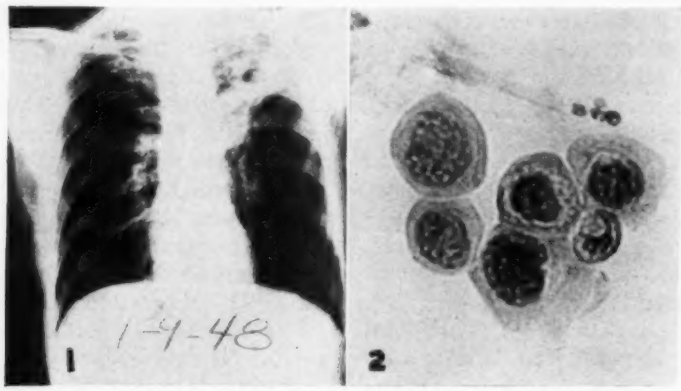
[1] From the University of California Medical Service, San Francisco Hospital, and the San Francisco Department of Public Health. Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

logic sections with cells in sputum from known non-malignant pulmonary disease as well as proved carcinoma of the lung. This has been reported in greater detail in previous publications (16, 17).

The non-malignant components of the sputum and bronchial secretions include: squamous epithelial cells from the mouth, pharynx, and portions of the larynx; columnar cells shed from the trachea and bronchi; blood cells; histiocytes and macrophages; and cells shed from areas of metaplasia of the respiratory tract which must be differentiated from malignant cells.

When adequate criteria are present, the cells may be considered definitely malignant. Cells showing some malignant characteristics, but insufficient for relative certainty of their nature, are reported as suspicious for malignancy.

The requirements for successful application of this method of diagnosis are: proper use of technical procedures, personnel adequately trained in cytologic diagnosis, and an objective, conservative scientific approach to the results obtained with this laboratory procedure. Although this method is still in the investigative stage, we believe that it has a definite value in drawing suspicion to, establishing, or confirming the diagnosis of bronchogenic carcinoma. Diagnosis may be made in some cases in which x-ray and bronchoscopic examination reveals no positive evidence of malignancy. However, this procedure does not diminish the need for the immediate institution of all available diagnostic technics in any patient suspected of having carcinoma of the lung.



Figs. 1 and 2. Case 1. Fig. 1. Roentgenogram suggesting a diagnosis of tuberculosis. Fig. 2. Malignant cells from sputum. Note high nuclear-cytoplasm ratio, irregular size and shape of the nuclei, and hyperchromatism.

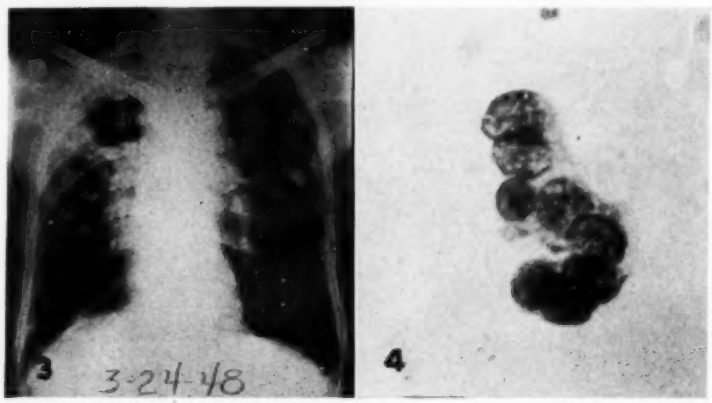
Malignant elements may appear as aggregations of cells with pleomorphic nuclei and may be crowded together. The cells may be large, or even huge, and usually show a high nucleus-to-cytoplasm ratio. The nucleus may be irregular with sharp protrusions. The nuclear chromatin may be dense, smudged in appearance, or may show irregular condensations with sharp, clear, "moth-eaten" areas. The nuclear membrane is frequently heavy. The nucleoli may be prominent, pleomorphic, or multiple. In addition to these general characteristics, present in whole or in part, cells from epidermoid carcinoma may show cornified cytoplasm and pearl formation. Adenocarcinoma cells may show huge vacuoles. Otherwise, their abnormalities are like those mentioned above.

REPORT OF SIX CASES

The following six cases are reported to illustrate the use of the cytologic technic in the diagnosis of bronchogenic carcinoma.

CASE 1: A 78-year-old hard-rock miner entered the hospital complaining of sharp chest pain on the left, which was more pronounced when he coughed.

He had noticed it for about six weeks. For several weeks the cough had produced blood-tinged sputum. There had been a weight loss of 15 pounds in the previous year. The patient was dyspneic and coughed intermittently during examination. Positive findings included limited excursion of the thoracic cage due to pain, hyperresonant lung fields with signs of emphysema, an enlarged nodular prostate, and a tender nodular epididymis. The roentgenogram on admission revealed evidence of what was considered to be an inflammatory process in the upper third of the left lung field and a cavity about 2.5 cm. in diameter (Fig. 1). In view of these findings, the patient was admitted to the tuberculosis ward, but sputum examination showed no acid-fast bacilli. Shortly after entry, malignant cells were found in the sputum (Fig. 2). Following this report, bronchoscopy was performed, showing an essentially normal bronchial tree. A month later, supraclavicular lymph node biopsy revealed epidermoid carcinoma.



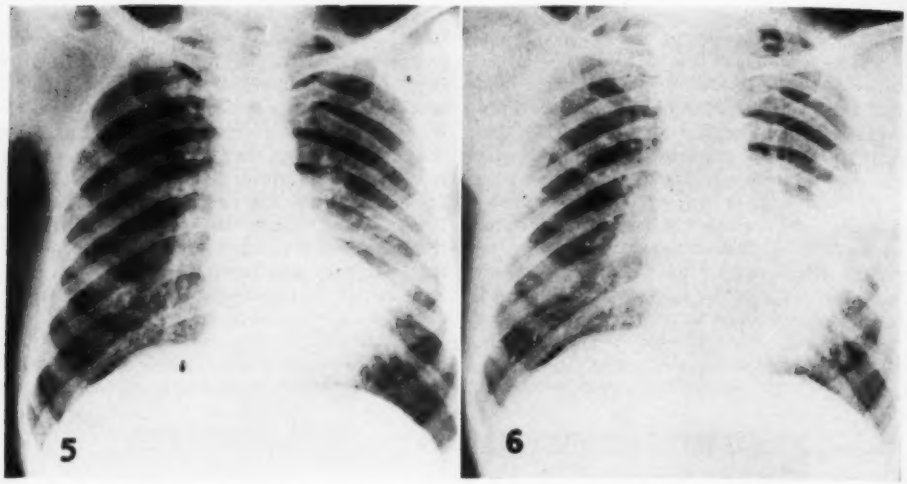
Figs. 3 and 4. Case 2. Fig. 3. Roentgenogram suggestive of chronic inflammatory disease. Fig. 4. Malignant cells from the sputum, showing "crowding," scanty cytoplasm, and hyperchromatism.

This patient presents an example of an upper-lobe bronchogenic carcinoma which could not be visualized bronchoscopically. The roentgenogram was interpreted as suggesting tuberculosis. The finding of malignant cells in the sputum pointed to the correct diagnosis.

CASE 2: A 52-year-old cook entered the hospital on Feb. 18, 1948. He had had a cough for about six months, which was productive of one-half cup of purulent sputum daily. He was dyspneic and emaciated, and his fingers were clubbed. Râles were present throughout all lung fields. A roentgenogram made at this time revealed infiltration and a large cavity in a shrunken right upper lobe, which was interpreted as representing chronic inflammatory disease (Fig. 3). The sedimentation rate was 26 (CSR). The sputum was examined for acid-fast organisms, but none was found and a tuberculin test (O.T. 1:1000) was negative. On bronchoscopy the bronchial tree appeared to be normal. Secretions from the upper lobe bronchus, as well as sputum, were examined, but malignant cells were not found. A right axillary lymph node biopsy was done and pathologic examination revealed evidence of chronic inflammation. Since the sputum was very thick and purulent, a course of penicillin and potassium iodide therapy was given for twelve days. Malignant cells were then found in the sputum (Fig. 4). Bronchoscopy was repeated, with normal findings. Two additional cervical lymph node biopsies showed chronic lymphadenitis. On May 27, 1948, the patient underwent pneumonectomy, and on pathologic examination an undifferentiated bronchogenic carcinoma of the secondary bronchus of the right upper lobe was found.

Radiological findings in this case were equivocal. Two bronchoscopies and three lymph node biopsies provided no evidence of malignant disease, nor did five sputum specimens and one bronchoscopic smear. After a course of penicillin and potassium iodide to reduce suppuration, decrease edema of the bronchial lumen, and facilitate drainage, malignant cells were found and diagnosis was thus established.

CASE 3: A 61-year-old janitor entered a hospital out-patient clinic, complaining of left chest pain for three months, night sweats, a slight productive cough, and a weight loss of 10 pounds. He had had one episode of mild hemoptysis two months before entry. The thorax was emphysematous and wheezes



Figs. 5 and 6. Case 3. Fig. 5. Original roentgenogram, interpreted as showing chronic pneumonia. Fig. 6. Roentgenogram made five months later, suggesting the possibility of a malignant lesion though tuberculosis was considered a more likely diagnosis.

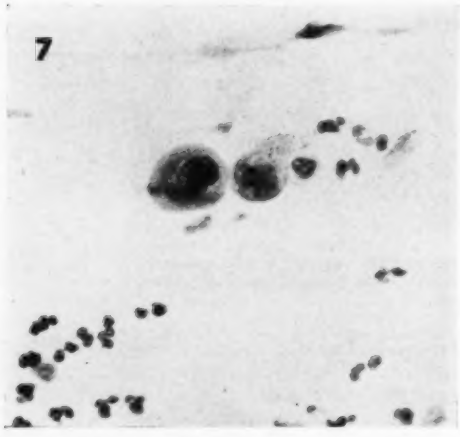


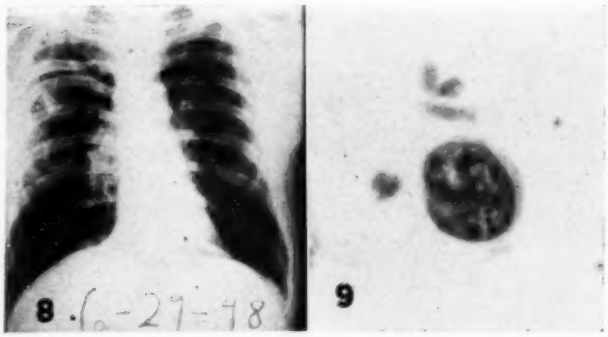
Fig. 7. Case 3. Malignant cells from sputum, showing large, irregular, hyperchromatic nuclei.

were heard throughout both lung fields, with decreased breath sounds and dullness over the left scapular region. The roentgenogram showed a fibrotic process in the left mid-lung field, which was interpreted to indicate the presence of a chronic pneumonia (Fig. 5). Five months later the roentgenogram revealed an increase in the density extending into the left mid-lung field with "honeycombing" (Fig. 6). Although tuberculosis was considered as the most likely diagnosis, the possibility of malignant disease of the lung was suggested. Tomograms revealed occlusion of the left lingular bronchus. Bronchoscopy showed a rigid deformed left main stem bronchus. At this time malignant cells were found in the sputum on the first examination (Fig. 7). A left pneumonectomy was performed. Sections of the lung revealed epidermoid carcinoma. Several months later the patient was feeling well and gaining weight.

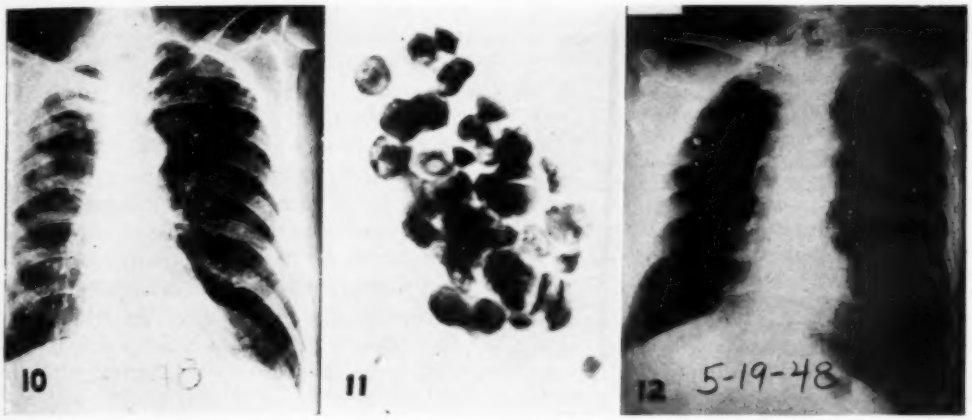
In this case, eight months elapsed between the onset of symptoms and the final diagnosis. The sputum was not submitted for cytologic study until five months after the patient was first examined.

CASE 4: A 55-year-old man had had pneumonia three months before hospital entry. After this illness, which was treated at home, roentgenograms had shown a thin-walled cavity in the right mid-lung field (Fig. 8). Until hospitalization, the patient had continued to raise moderate amounts of purulent sputum and lose weight. A coccidioidin skin test was negative, as was examination of the sputum for tubercle bacilli. Sputum was then submitted for cytologic examination and malignant cells were found (Fig. 9). Following this, bronchoscopy was done and a carcinoma of the right upper lobe bronchus was found. A cervical lymph node biopsy showed epidermoid carcinoma.

This patient presented a clinical picture and x-ray findings suggesting an inflammatory process with cavitation. Malignant cells in the sputum pointed to the diagnosis of bronchogenic carcinoma. Unfortunately, in spite of a relatively short history, the condition was already inoperable.



Figs. 8 and 9. Case 4. Fig. 8. Roentgenogram showing thin-walled cavity in the right mid-lung field. Fig. 9. Malignant cell from the sputum. Note the large size, scanty cytoplasm, and irregular chromatin condensations.

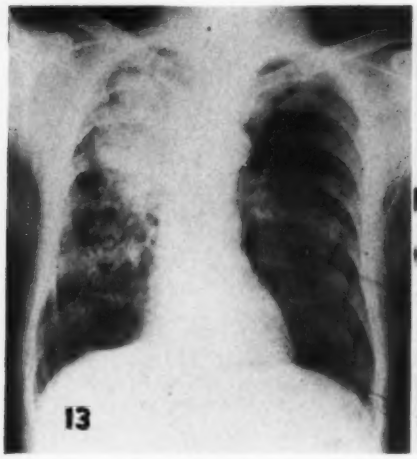


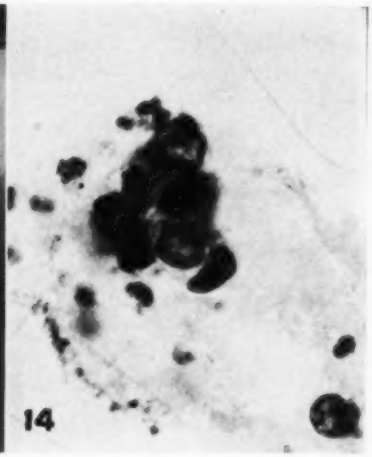
Figs. 10–12. Case 5. Fig. 10. Roentgenogram showing area of density extending out from right hilar region. Fig. 11. Malignant cells from sputum with "crowding" of small hyperchromatic nuclei and scanty to absent cytoplasm. Fig. 12. Later roentgenogram showing apparent widening of the mediastinum.

CASE 5: The patient was a 59-year-old turkey raiser who had had a productive cough, with bloody sputum, for three months prior to his first examination. He had lost weight and was dyspneic. The roentgenogram showed a density extending out from the right hilar region (Fig. 10). Bronchoscopy revealed slight reddening of the left main stem bronchus. Serial roentgenograms in the months following showed no change. Four months after the onset of symptoms, sputum was submitted for study, and malignant cells were found (Fig. 11). Hemoptysis and the productive cough persisted, and repeated sputum examinations consistently showed malignant cells.

Four months after the first demonstration of malignant cells, the patient was hospitalized. At that time, roentgenograms showed what appeared to be widening of the mediastinum (Fig. 12). Physical examination revealed coarse bronchial breath sounds and inspiratory wheezing over the left mid and upper lung fields. A repeat bronchoscopic examination at this time revealed a cauliflower-like lesion at the level of the carina. On biopsy of the mass, a diagnosis of carcinoma of the typical oat-cell type was made. The lesion had ulcerated through the mucous membrane and invaded deep into the muscularis of the bronchus. Because of its location and mediastinal involvement, the carcinoma was considered inoperable.

This patient had equivocal roentgenograms. The first bronchoscopic examination was not diagnostic. Malignant cells were consistently found in the sputum for many months before a repeat bronchoscopic examination revealed an inoperable malignant lesion.





Figs. 13 and 14. Case 6. Fig. 13. Roentgenogram showing a mass and dense infiltration in right upper lung field with infiltrative shadows in the left upper field. Fig. 14. Malignant cells from sputum, showing marked "crowding," hyperchromatism, and irregular nuclei with scanty cytoplasm.

CASE 6: A 65-year-old man entered the hospital with a history of a cough with sputum and hemoptysis and a 10-pound weight loss in the previous two months. In the two weeks preceding hospitalization, dyspnea and right-sided apical pleuritic pain developed. Examination revealed lymphadenopathy in the right supraclavicular fossa. The right vocal cord was paralyzed. The anterior right lung field was dull on percussion; râles and decreased breath and voice sounds were heard. Acid-fast organisms were found in the sputum on numerous occasions.

The roentgenogram showed a mass and dense infiltration in the right upper lung field, with infiltrative densities in the left upper lung field (Fig. 13). Bronchoscopic findings were within normal limits. Bronchograms demonstrated a lesion obstructing the right upper lobe bronchus. A supraclavicular lymph node biopsy showed evidence of tuberculosis. Seven months after the patient entered the hospital, cytologic examination of the sputum revealed malignant cells in the first specimen submitted (Fig. 14). The patient died a month later. Autopsy confirmed the diagnosis of adenocarcinoma of the right upper lobe bronchus and coexistent tuberculosis.

This patient was suspected of having bronchogenic carcinoma and pulmonary tuberculosis for many months before cytologic studies established the diagnosis of cancer. It is possible that, if the sputum had been examined on admission to the hospital, surgical exploration might have been carried out.

RESULTS

In our series, 2,228 specimens of sputum or of secretions obtained bronchoscopically, representing 671 cases, have been submitted to cytologic study. Of these 671 cases, 100 have been proved to be cancer of the lung. Sputum from 89 of the 100 proved cases was examined and cells "consistent with malignancy" or "suspicious" were found in 63, or 71 per cent. Bronchoscopically obtained secretions from 45 proved cases were examined and positive findings were reported in 26 (58 per cent).

When a complete series of five sputum specimens was studied, the accuracy of cytologic diagnosis was increased to 90 per cent (63 of 69 proved cases). In 20 of the 26 proved cases missed by sputum examination, the number of specimens examined was inadequate. In 12 cases a single specimen was submitted.

The caution exercised in the application of diagnostic criteria has been justified, since in no case in which cells were reported as "consistent with malignancy" and in which pathologic examination was obtained, did the sections fail to reveal cancer. In one case which was reported "suspicious for malignancy" the patient later under-

went lobectomy and a lung abscess was found; several areas of metaplasia and many abnormal macrophages were present, but no malignant lesion was demonstrable.

When sputum and bronchoscopically obtained smears from the same case have been examined, the accuracy has been comparable. The relative ease with which sputum smears may be prepared makes this diagnostic procedure available where adequate diagnostic facilities, such as bronchoscopy, are lacking.

COMMENT

In cases in which equivocal silent lesions of the lungs and bronchi were discovered by roentgen examination of apparently healthy individuals, as well as in cases of clinically manifest chest disease, it has been possible, in many instances, to determine the malignant nature of the lesions when exfoliated neoplastic cells were found in sputum or bronchial aspirations. As physicians become more cognizant of the difficulties in diagnosing this masquerading chest disease, they will utilize this new diagnostic aid in addition to the established procedures. It must again be emphasized that this technic has definite limitations. Further evaluation under rigid investigative control is necessary before it can take its proper place in the diagnosis of bronchogenic carcinoma.

516 Sutter St.
San Francisco 2, Calif.

REFERENCES

1. HARRINGTON, S. W., AND MOERSCH, H. J.: Primary Carcinoma of the Lung. S. Clin. North America **21:** 1083–1098, August 1941.

2. FARBER, S. M., AND TOBIAS, G.: Primary Carcinoma of the Lung (200 Autopsy Cases). Rev. Panamericana de med. y cir. del torax **1:** 82–97, October-November 1947.

3. OCHSNER, A., DE BAKEY, M., AND DIXON, J. L.: Primary Cancer of the Lung. J. A. M. A. **135:** 321–327, Oct. 11, 1947.

4. CHURCHILL, E. D.: Primary Carcinoma of the Lung. J. A. M. A. **137:** 455–461, May 29, 1948.

5. OVERHOLT, R. H., AND RUMEL, W. R.: Clinical Studies of Primary Carcinoma of the Lung; Analysis of 75 Cases, 21 of Which Were Treated by Pneumonectomy or Lobectomy. J. A. M. A. **114:** 735–742, March 2, 1940.

6. HUNTER, W. C., AND RICHARDSON, H. L.: Cytologic Recognition of Cancer in Exfoliated Material from Various Sources; Useful Modifications of the Papanicolaou Technic. Surg., Gynec. & Obst. **85:** 275–280, September 1947.

7. PALACIO, J., AND MAZZEI, E. S.: Tumores primitivos malignos bronchopulmonares. Buenos Aires, "El Ateneo," 1940.

8. DUDGEON, L. S., AND WRIGLEY, C. H.: On Demonstration of Particles of Malignant Growth in Sputum by Means of Wet-Film Method. J. Laryng. & Otol. **50:** 752–762, October 1935.

9. WANDALL, H. H.: A Study on Neoplastic Cells in Sputum as a Contribution to the Diagnosis of Primary Lung Cancer. Acta. chir. Scandinav. (Suppl. 93) **91:** 1–143, 1944.

10. PAPANICOLAOU, G. N., AND TRAUT, H. F.: Diagnosis of Uterine Cancer by the Vaginal Smear. New York, Commonwealth Fund, 1943.

11. PAPANICOLAOU, G. N.: Diagnostic Value of Exfoliated Cells from Cancerous Tissues. J. A. M. A. **131:** 372–378, June 1, 1946.

12. HERBUT, P. A., AND CLERF, L. H.: Bronchogenic Carcinoma; Diagnosis by Cytologic Study of Bronchoscopically Removed Secretions. J. A. M. A. **130:** 1006–1012, April 13, 1946.

13. WOOLNER, L. B., AND MCDONALD, J. R.: Bronchogenic Carcinoma: Diagnosis by Microscopic Examination of Sputum and Bronchial Secretions: Preliminary Report. Proc. Staff Meet, Mayo Clin. **22:** 369–381, Sept. 3, 1947.

14. MCKAY, D. G., WARE, P. F., ATWOOD, P. A., AND HARKEN, D. E.: Diagnosis of Bronchogenic Carcinoma by Smears of Bronchoscopic Aspirations. Cancer **1:** 208–222, July 1948.

15. LIEBOW, A., LINDSKOG, G., AND BLOOMER, W. E.: Cytological Studies of Sputum and Bronchial Secretions in the Diagnosis of Carcinoma of the Lung. Cancer **1:** 223–233, July 1948.

16. FARBER, S. M., BENIOFF, M. A., AND TOBIAS, G.: Primary Carcinoma of the Lung; Diagnosis by Cytological Studies of Sputum and Bronchial Secretions. California Med. **69:** 95–99, August 1948.

17. FARBER, S. M., BENIOFF, M. A., FROST, J. K., ROSENTHAL, M., AND TOBIAS, G.: Cytologic Studies of Sputum and Bronchial Secretions in Primary Carcinoma of the Lung. Dis. of Chest **14:** 633–664, September-October, 1948.

SUMARIO

Diagnóstico del Carcinoma Broncógeno con las Técnicas Citológicas

En los casos en los que se descubrieron con el examen roentgenológico lesiones silenciosas equívocas en personas sanas así como en aquellos de afección torácica clínicamente manifiesta, ha sido posible muchas veces determinar la naturaleza maligna del estado por el hallazgo de células neoplásicas exfoliadas en el esputo o en las secreciones bronquiales aspiradas.

En el presente estudio, se consideró necesario examinar por lo menos cinco ejemplares diarios de esputo antes de

aceptar como adecuado el examen citológico. En 63 de 89 casos comprobados de cáncer del pulmón, o sea en 71 por ciento, descubriéronse células compatibles con, o indicativas de, malignidad. Al examinar una serie completa de cinco ejemplares, los diagnósticos citológicos acertados se elevaron a 90 por ciento. De los 26 casos que pasó por alto el examen del esputo, en 20 el número de ejemplares fué inadecuado. El examen de las secreciones bronquiales obtenidas broncoscópicamente resultó exacto en 58 por ciento de 45 casos.

Se describen seis casos típicos.

DISCUSSION

(Papers by Budd; Rosemond, Burnett, and Hall; Farber, Benioff, and McGrath)

David A. Wood, M.D. (San Francisco, Calif.): I have very much enjoyed this group of papers presented by Dr. Budd, Dr. Rosemond, and Dr. Farber. As a pathologist I have not had a vast experience with the aspiration method of diagnosis. This may be due in part to the conservatism of our tumor clinic at Stanford. We have had some experience with aspiration biopsies in advanced lesions of the breast, that is, in anatomical Stage 3 lesions. Inasmuch as we do not believe in preoperative irradiation of anatomical Stage 2 mammary carcinomas, we have had little or no experience with aspiration biopsy in that group. Before a course of radiation therapy is embarked upon in advanced carcinoma, we want tissue corroboration, and needle aspiration has proved very satisfactory. Our conservatism has been based upon theoretical considerations rather than technical difficulties. From the point of view of the pathologist, the preparations which we have secured have been satisfactory by and large. Occasionally we have resorted to aspiration biopsies in cases of advanced carcinoma of the lip; in lymph node involvement, for example, a positive aspiration, showing the presence of squamous epithelium cells, is of considerable value. We have deplored the use of aspiration, however, with lymph nodes in the lymphatoid dyscrasias. We have had a moderate amount of experience in aspiration biopsies of the liver, especially in cases of suspected hepatitis.

In regard to the lung, we have had no experience at all. We have felt that here the advantages of aspiration biopsy certainly do not outweigh the theoretical dangers. Dr. Rosemond has pointed out that they obtained positives in 61 per cent of their cases. Well, what are our objections? In the first place, theoretically, tumor seeding along the needle track. Dr. Rosemond has attempted to answer that objection, and to deny it. It may be that differences in technic enter into the question. We have in mind the very definite experience of such people as Dr. Alton Ochsner, who has reported cases in which tumor seeding along the track has been observed, and we are afraid of it. Then, too, there is always danger of empyema. Frequently one must go through an infected field, and there is danger of carrying some of the infected material into the pleural space. Similarly, there is danger of pneumothorax. We have been especially fearful of promoting vascular metastasis. In bronchogenic carcinoma there is a marked increase in bronchial artery vascularity, in contrast to metastatic carcinoma, where there is no increase in vascularity. So there is the danger of metastatic nodules being promoted in the brain, and also the danger of septic embolism to the brain. In my opinion, the procedure is fraught with certain hazards which cannot be dismissed lightly.

With regard to bronchogenic cancer, it must be remembered that 85 per cent of primary tumors of the lung are bronchogenic and usually occur about the hilus or major bronchi. In view of the experience of people like Dr. Farber locally, Woolner of the Mayo Clinic, and Herbut of Jefferson, that a very high percentage of positives can be obtained by cytological study of the bronchial secretions and sputum, it is my opinion that this more simplified method of study is preferable to the more complicated and more hazardous method of aspiration.

Minimal Tuberculosis[1]

Problems in Roentgenologic Interpretation

I. D. BOBROWITZ, M.D.,[2] and ALLAN HURST, M.D.[3]

THE DIAGNOSIS of pulmonary tuberculosis by roentgenographic examination, particularly in routine and mass chest x-ray surveys, has become a common practice. This is especially true as regards minimal lesions, where it is admitted that laboratory and clinical findings are often absent or inadequate to help in early diagnosis. Since basic criteria for the determination of the clinical significance of the minimal lesion have not been established, it has become an increasingly frequent custom of chest physicians and roentgenologists to attempt to read from the film the clinicopathologic nature of the lesion for the purpose of proper disposition.

The terms used in the roentgenologic description of minimal tuberculous lesions imply a certain pathologic significance for each type of infiltration, *i.e.*, exudative, exudative-productive, productive-fibrotic, and fibro-calcific. Reisner and Downes (1) have provided the following excellent definitions for the roentgenologic character of the infiltration:

"*Exudative:* Roentgenologically, the density usually shows rather ill-defined borders; occasionally it may be well circumscribed; it is 'soft' in appearance, either round or irregular in shape. The size is variable, usually ranging from one to two or three centimeters in diameter. The individual lesion may represent either a single focus or it may be composed of several smaller confluent densities. The intensity of the shadow depends on the size of the lesion, it may be either homogeneous or flocculent in appearance.

"*Productive and Fibrotic:* From the roentgenological appearance a distinction may be made between two main forms, namely: (*a*) discrete nodular densities, usually multiple, of small size, showing well defined borders, 'hard' in appearance, either round or irregular in shape; (*b*) strand-like or linear densities, sharply outlined, often irregular in shape and distribution. The majority of the cases included in this category present a combination of form 'a' and 'b'.

"*Exudative-Productive:* This form may be regarded as an intermediate group between the two preceding types, the roentgenological findings presenting a combination of the features of both the exudative and productive-fibrotic elements in varying proportions.

"*Fibro-Calcific Form:* Roentgenologically, the changes consist of sharply defined nodular densities, showing either round or irregular borders. The nodules are usually multiple; their distribution is scattered; they are generally of small size, measuring several millimeters in diameter, only rarely exceeding one centimeter. The intensity of the shadows is of a type usually interpreted as characteristic of calcium deposition. Such findings often occur in combination with changes indicative of strand-like and linear fibrosis."

In a recent study (2) we attempted to determine the clinical significance and prognosis of minimal pulmonary tuberculosis in a group of 220 sanatorium cases. Only those cases that were minimal according to the classification of the National Tuberculosis Association and with the characteristic roentgenologic picture of pulmonary tuberculosis of the reinfection type were included. We related the roentgenologic, clinical and laboratory findings in these cases at the time of admission to the sanatorium to the risk of progression during a long follow-up period. In order to observe the behavior of the lesion, all of the x-ray data were obtained from actual inspection of the roentgenograms in the institution and during the post-sanatorium phase. This paper is based on problems we found related to the roentgenologic interpretation and evaluation of minimal tuberculosis.

Satisfactory observation and description

[1] From the Municipal Sanatorium, Otisville, N. Y. (one of the institutions of the Department of Hospitals of the City of New York). Accepted for publication in April 1948.

[2] Medical Superintendent, Municipal Sanatorium, Otisville, N. Y.

[3] Formerly Supervisor of Clinics, Bureau of Tuberculosis, New York City Department of Health; now Medical Director, National Jewish Hospital, Denver, Colo.

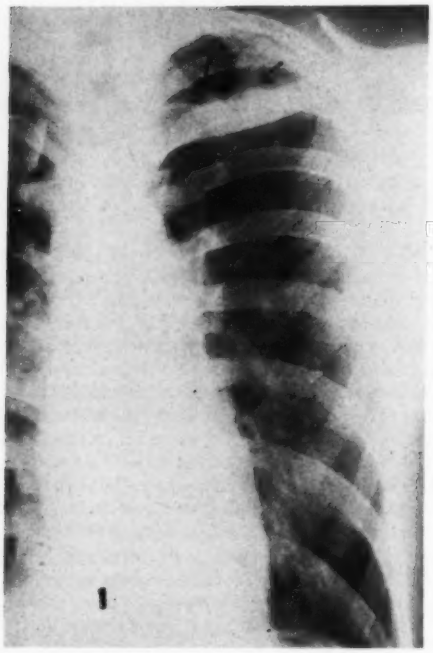


Fig. 1. Case 1. March 29, 1946. Few nodules in the left infraclavicular area; suspicious lesion in left subclavicular region.

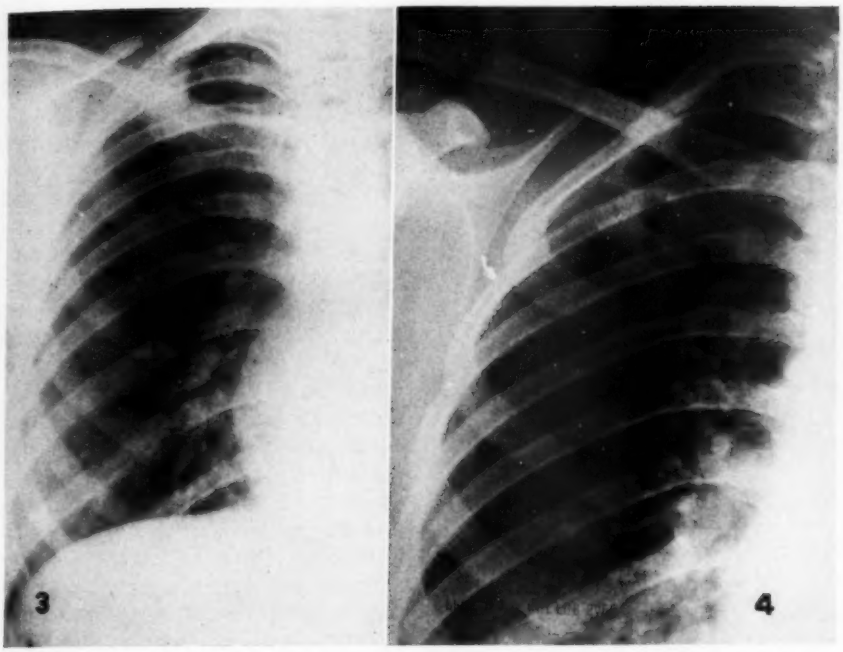
of the tuberculous lesion are not possible unless the infiltration is completely and clearly visualized. Several general principles should be remembered in this respect. A lesion hidden by the clavicle or first anterior rib can be definitely delineated only by a lordotic or apical view. To visualize infiltrates located under other ribs or obscured by the heart shadow or scapula, oblique views may be necessary. Special studies, such as spot films or oblique or lateral views, may be required for lesions in the periphery of the lung field. It is often impossible to determine the extent and type of infiltration in the vicinity of the root areas without oblique or lateral roentgenograms. Less often stereoscopic films or laminagrams may be required. The technical factors are, of course, extremely important, for the radiographic appearance of the lesions can be varied and the lesions made to appear soft or hard by changes in x-ray exposure and variations in the film development process.

Fig. 2. Case 1. March 29, 1946. Lordotic apical view. Lesion identified as two round foci, with a few nodules nearby.

The following cases, 1 and 2, emphasize the point that no attempt should be made to evaluate a lesion unless it can be visualized completely and satisfactorily on the roentgenogram. Special roentgenographic views should be used whenever the routine postero-anterior film is found not to be adequate.

Case 1 (*J. J., 23-year-old white male*): Figure 1 shows a few small productive nodules in the left infraclavicular area on a level with the first anterior rib and interspace, and a suspicious lesion obscured by the first rib and clavicle. It is impossible to state definitely, on the basis of this film, how much tuberculosis is present and what kind of infiltration exists. A lordotic apical view obtained on the same day (Fig. 2) clearly illustrates that a lesion is present and the nature of the infiltration—two coalescent, homogeneously dense round foci, with several small nodules beneath and one lateral to the larger foci.

Case 2 (*V. J., 18-year-old white female*): Figure 3 indicates a mixed infiltration in the right subclavicular region. The type and character of the lesion cannot be defined accurately because of obscuration by the clavicle and first anterior rib. An apical view (Fig. 4), however, taken on the

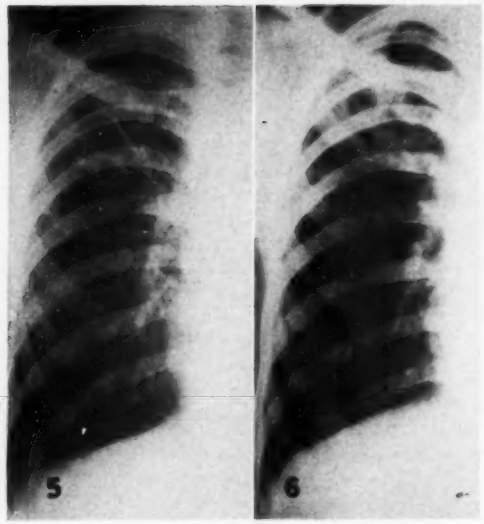


Figs. 3 and 4. Case 2. Fig. 3 (April 6, 1945). Poorly defined lesion in right subclavicular area. Fig. 4. Apical view, same day, showing a definite cavity within the infiltration.

same day, demonstrates a definite cavity within the infiltration (gastric contents positive for tubercle bacilli). Without complete roentgenologic study, this would have been considered a minimal case of tuberculosis, whereas actually a cavernous, moderately advanced lesion was present. Inclusion of such cases by mistake in a group of supposedly minimal lesions can, of course, unfavorably influence the prognosis of minimal tuberculosis. Moreover, essential treatment may be delayed if the true nature of the lesion is unknown.

It was not always a simple matter to fit the lesion in one of four categories and to classify it pathologically. In the first place, and as already mentioned, technical factors are important, for the infiltration could be made to look denser and smaller, or larger and softer, by variations in exposure and differences in the developing process. Secondly, the personal equation was important. In the frankly exudative or fibro-calcific infiltration we would usually agree about the classification of the lesion. But in the large group of mixed infiltrations, the exudative-productive and productive-fibrotic, there were divergence and difference of opinion. Occasionally considerable discussion preceded agreement about the roentgenogram. Birkelo *et al.* (3) report great variation in the interpretation of 14 × 17-inch celluloid films by a group of five experienced radiologists and chest specialists, and considerable differences in independent readings of the same films by the same individual.

Exudative lesions were rare among the sanatorium cases, but when they did occur they were fairly typical. Exudative-productive lesions are quite common, yet often hard to differentiate from the productive-fibrotic type, especially in under-exposed films or where the lesion is in the periphery of the pulmonary field. The overlying soft tissues may give the lesion the appearance of exudation. When groups of productive nodules become conglomerate, there is a tendency to regard the lesion as exudative-productive. Productive-fibrotic



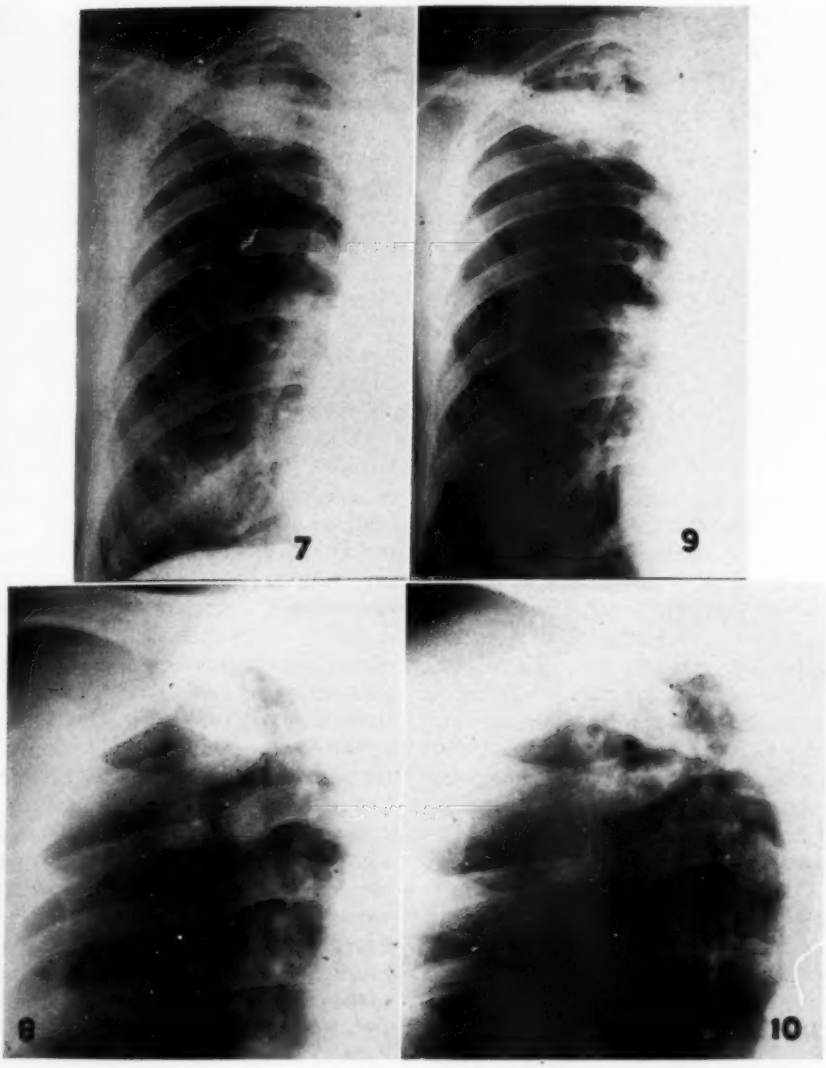
Figs. 5 and 6. Case 3. Fig. 5 (Jan. 13, 1940). Dense linear productive scar in right first anterior interspace. Fig. 6. Film made three years earlier, showing heavy-walled cavity in right infraclavicular area, which had closed to form the linear scar shown in the later view.

lesions also represent a large heterogeneous group of linear and nodular infiltrations. It is not always easy to decide if nodules are purely productive or exudative-productive. There is a tendency to call larger nodules exudative-productive and smaller ones productive. Arbitrary decisions of this type may lead to obvious difficulties. Fine, linear, fibrotic areas and typically scattered productive nodules are simplest to classify. In both exudative-productive and productive-fibrotic lesions, the classification was more difficult when the infiltrations, instead of being few and scattered and clearly delineable, were many, diffuse, mixed in type, and conglomerate. When fibro-calcific lesions are scattered or make up the total extent of the infiltration, there is little difficulty in interpretation of the film. When they are combined with other types of lesions, it may be hard to say when the case belongs in one category or another.

The subsequent roentgenological behavior of the lesions did not always agree with that expected from the particular pathological type ascribed to the infiltration. Thus lesions considered soft or exudative-productive might remain apparently unchanged for many months before resolution or fibrosis occurred. On the other hand, lesions considered productive would change and gradually become thinner or smaller, more discrete and well defined, or evolve as a progressive disseminated infiltration.

In our study, the difficulties present in attempting to make pathological interpretations of the infiltration seen in the roentgenogram were quite apparent. In addition, our observations emphasized how unwise it is to predict the outcome or significance of the minimal lesion on the basis of a single film. It is impossible to know the past evolutionary stages of the lesion from one roentgenogram or to make any conclusions with assurance about the future development of the infiltration. The following cases serve to illustrate this point.

Case 3 (*W. W., 23-year-old white male*): Figure 5 represents the film at time of admission to the sanatorium, Jan. 12, 1940. A dense, linear, fibrotic shadow is present in the first right anterior intercostal space. There are a few scattered, fibrotic nodules and strands in the medial portion of the interspace and on a level with the second anterior rib. A roentgenogram taken in this case three years previously, at the time of diagnosis, Dec. 23, 1936 (Fig. 6), reveals a heavy walled cavity, 2 cm. in diameter, in the lateral half of the first right anterior interspace, with nodular and coalescent areas of infiltration extending from the inner inferior portion of the right apex to the third anterior rib. The sputum was positive at this time and became negative after four months. The cavity in the right upper lobe closed with complete bed rest. After cavity closure, a heavy, thick linear infiltration resulted and in time this became thinner to form the linear scar seen in Figure 5. On the basis of a single film (Fig. 5) the lesion in the right upper lobe might have been considered a minimal one; yet inspection of previous roentgenograms dating from the onset of the illness revealed



Figs. 7–10. Case 4. Fig. 7 (March 24, 1944). Coalescent infiltration in right apex and subclavicular area. Fig. 8. Apical lordotic film of same date, showing infiltration clearly defined as one large and two small round tuberculous foci. Fig. 9. Earlier film (May 7, 1943) showing large suspicious cavity in right apex. Fig. 10. Lordotic apical film of same date as Fig. 9, showing large, heavy-walled cavity, clearly defined. It was this cavity that filled and closed to form the large round focus seen in Figs. 7 and 8.

a tuberculous cavity as the precursor of the linear scar, this so-called minimal lesion.

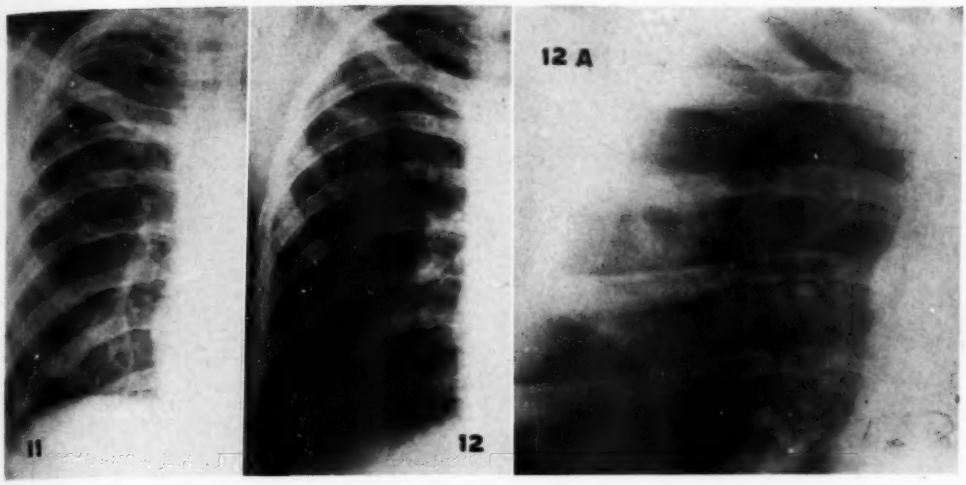
The importance of bronchial occlusion in the healing of tuberculous cavities has been emphasized by Coryllos (4). The closure of tuberculous cavities with the formation of a linear, fibrotic scar has been described by Tchertkoff and Bobrowitz (5). As healing changes progress, the wall of the bronchus draining the cavity appears irregular, the lumen narrows, particularly at the bronchocavitary junction, and then obstruction occurs. Studies with contrast substances, Taylor and Bobrowitz (6) have shown the irregularities in the draining bronchi, narrowing, and then occlusion of

the lumen, with closure of cavities. With the obstruction of the bronchus, the air within the cavity is absorbed, the cavity closes or collapses, and a linear, dense fibrous band is the end-result. (With obstruction of medium-sized bronchi, segmental atelectasis may also occur.) This scar has a characteristic appearance and, when seen on roentgenographic examination, may arouse suspicion and lead one to check back and discover former cavity closures.

Case 4 (O. S., 48-year-old colored male): Figure 7 (March 24, 1944) shows a coalescent exudative-productive area of infiltration in the right apex and subclavicular region. An apical lordotic film obtained the same day (Fig. 8) clearly outlines the type of infiltration. A large, homogeneously dense, sharply defined circular or round focus of infiltration is seen at the level of the first right anterior rib and interspace, with two smaller similar foci below. On the basis of these films, this lesion could be interpreted as minimal in extent (and benign in nature). However, this round pulmonary tuberculous focus very frequently represents the end-result of tuberculous cavitation, as described by Bobrowitz (7). An earlier film in this case, taken ten months previously (May 7, 1943), is shown in Figure 9. The regular postero-anterior film made at that time demonstrates within the infiltration of the right apex a large area of lessened density, suggestive of cavitation. A lordotic apical film of the same date (Fig. 10) confirms the presence of a large, heavy-walled cavity. Beneath the cavity are two small loosely coalescent areas of infiltration. A gastric culture was positive for tubercle bacilli in this patient, substantiating the diagnosis of tuberculous cavitation. Apparently, therefore, this cavity closed spontaneously with bed rest, the lumen became filled and, with inspissation of the contents, a typical circumscribed homogeneous, dense, round pulmonary focus formed.

A round focus, when seen on a single roentgenogram, should not be interpreted as a minimal lesion of benign nature. Serial observation is necessary, and all antecedent films should be reviewed to determine the true pathogenesis of the lesion. Frequent follow-up examination is important, because these circular lesions need close observation. The round foci may become smaller, more dense, and well defined, and retain their circular appearance. The decrease in size may be of marked degree, and the round focus may almost entirely absorb. On the other hand, the lesion may enlarge, softening and liquefaction may occur within the body of the focus, and the reopened cavity may cause a spreading tuberculosis.

Case 5 (C. N., 18-year-old white male): Figure 11 (Nov. 15, 1944) reveals a stellate or irregular, uneven-edged fibrotic area of infiltration in the lateral part of the first right anterior interspace. Part of the infiltration is hidden by the second anterior rib. A few fine fibrotic nodules are scattered in the remainder of the first interspace. Little change was apparent in later roentgenograms. The sputum, gastric secretion, and cultures, which had been negative since August 1944, continued so; the disease was considered arrested, and the patient was discharged in June 1945. A previous film in this case (Fig. 12, Feb. 11, 1944) reveals a thin-walled cavity, 2.0 cm. wide, with a fluid level in the lateral part of the chest on a level with the second anterior rib. There are scattered, nodular, exudative-productive areas of infiltration between the first and third anterior ribs. Figure 12A is a lordotic film of the same date (Feb. 11, 1944) which clearly visualizes the cavity in the right upper lobe. Gastric cultures were positive for tubercle bacilli in May and July 1944. The lesion in Figure 11 is minimal from the standpoint of extent and character, yet a roentgenogram nine months previously showed a definite cavity at its site. In this patient then, with complete bed rest, there was progressive shrinkage of the cavity and the end-result of its closure was a stellate scar. This small, irregular area of fibrosis is the third type of lesion seen roentgenographically (in addition to the round focus and

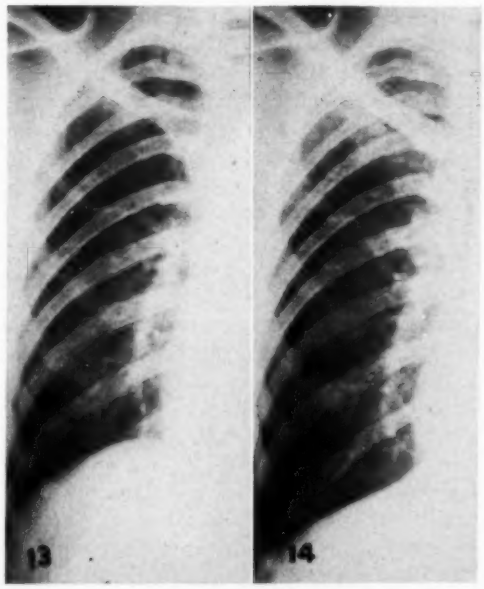


Figs. 11–12A. Case 5. Fig. 11 (Nov. 15, 1944). Stellate or irregular, uneven-edged fibrotic scar in lateral part of first right anterior interspace. Fig. 12. Earlier film (Feb. 11, 1944) showing cavity at level of second right anterior rib. This closed to form the stellate scar. Fig. 12A. Lordotic view of same date as Fig. 12, showing definite cavity in right upper lobe.

linear scar) which, though minimal in extent, represents obliteration of a tuberculous cavity.

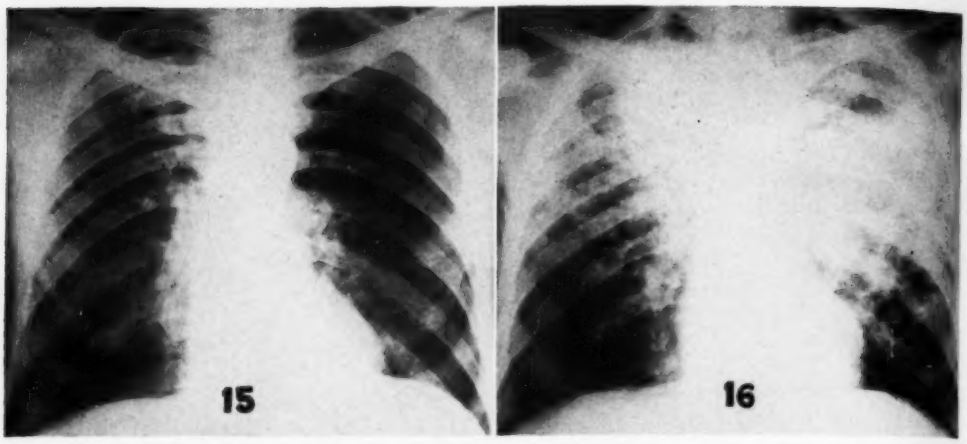
Case 6 (H. S., 25-year-old white male): Figure 13 (March 27, 1946) illustrates what might be considered a usual minimal lesion with exudative-productive nodules and strands in the right apex above the first right anterior rib, and a few similar lesions in the first anterior interspace. In checking back, however, a film taken fifteen months previously (Fig. 14, Dec. 4, 1944) was found to demonstrate a dense, nodular, exudative-productive type of infiltration in the right upper lobe, extending from the right apex to the third anterior rib and of moderately advanced degree. Therefore, the minimal lesion of Figure 13 is a residuum of an advanced type of infiltration of non-cavernous character.

We have emphasized the difficulties in attempting to understand what has happened to the minimal lesion in the past from examination of one or a few films. It is as serious a problem in the roentgenographic interpretation of minimal tuberculosis, and just as difficult, to try to indicate from examination of a single film what will occur in the future. The cases which follow illustrate this point:



Figs. 13 and 14. Case 6. Fig. 13 (March 27, 1946). Nodular and strand-like infiltration in right apex and first anterior interspace. Fig. 14. Earlier film (Dec. 4, 1944), showing exudative-productive infiltration in right upper lobe from apex to third anterior rib.

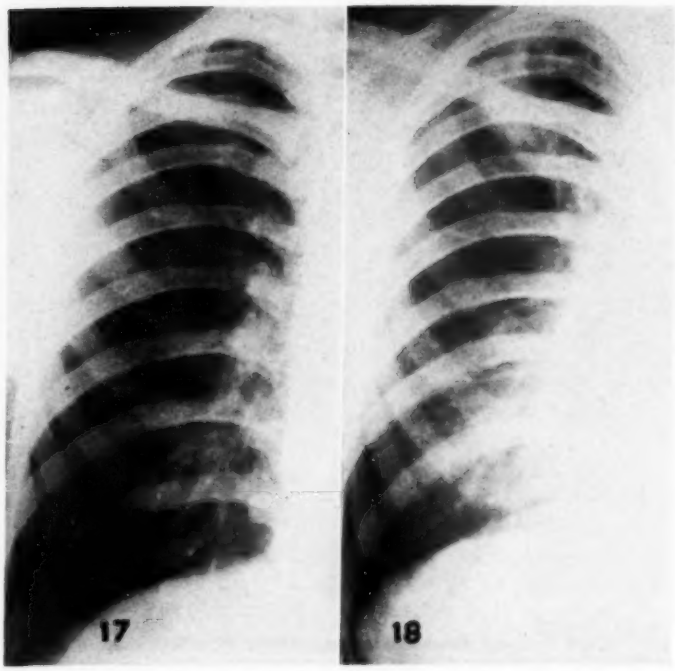
Case 7 (J. M., 54-year-old white male): Figure 15 (April 4, 1945) shows a minimal pulmonary tuberculous process in the right upper lobe. A linear and nodular pro-



Figs. 15 and 16. Case 7. Fig. 15 (April 4, 1945). Linear and nodular infiltration at level of right first anterior rib and interspace. Fig. 16. Film obtained six weeks later (May 17, 1945) showing soft nodular and coalescent lesions in upper two-thirds of both lung fields.

ductive-fibrotic type of infiltration extends from the lung root upward on a level with the first anterior rib and interspace. This film was taken six weeks prior to entrance into the sanatorium, at which time the patient complained of loss of weight, anorexia, and dry cough. A roentgenogram obtained on admission to the institution (Fig. 16, May 17, 1945) demonstrates that an extensive spread of the disease has taken place. Soft nodular and coalescent lesions are present in the upper two-thirds of both lung fields, with slightly more marked involvement on the left side. On sanatorium admission this patient was acutely ill, with weakness, dyspnea, loss of weight, fever, and anorexia. There were slight cough and expectoration. Examination revealed an emaciated, anemic appearing dyspneic man. The abdomen was distended due to ascites; liver and spleen were palpable, feet and ankles edematous. Auscultation showed much moisture over both lungs. Temperature, pulse, and respiration were elevated. Sputum was positive for tubercle bacilli. The sedimentation rate was increased and there was a moderate secondary anemia. The ascitic fluid was positive for tubercle bacilli on culture. The patient died within nine days after admission. Necropsy revealed extensive, evenly distributed, nodular patchy, and confluent areas of tuberculous consolidation in both lungs, with several small cavities. Tubercles were present in the liver, spleen, bone marrow, and mediastinal and abdominal lymph nodes.

In this case an innocuous looking, productive type of lesion evolves as a very extensive process in the form of a typical bilateral hematogenous dissemination, with caseous and cavernous areas. Moreover, the change in the minimal lesion took place very rapidly. (We have also noticed the appearance of a nodular, bilateral, hematogenous looking pulmonary type of infiltration by slow development over months or years from a unilateral lesion of minimal extent.) Viewing alone either the film at diagnosis or at time of death gives no complete picture of the sequence of events. Both films together, however, provide some idea of the pathogenesis of the tuberculous process. This case also indicates that roentgenographic interpretation of a minimal lesion can be aided by knowledge of the clinical picture (and bacteriological findings). Although the first fi'm, Figure 15, showed a fibrotic type of infiltration, the patient at the time gave a history of progressive loss of weight, anorexia, and dry cough. The symptoms provided a definite indication of tuberculous activity and were more impressive than the roent-

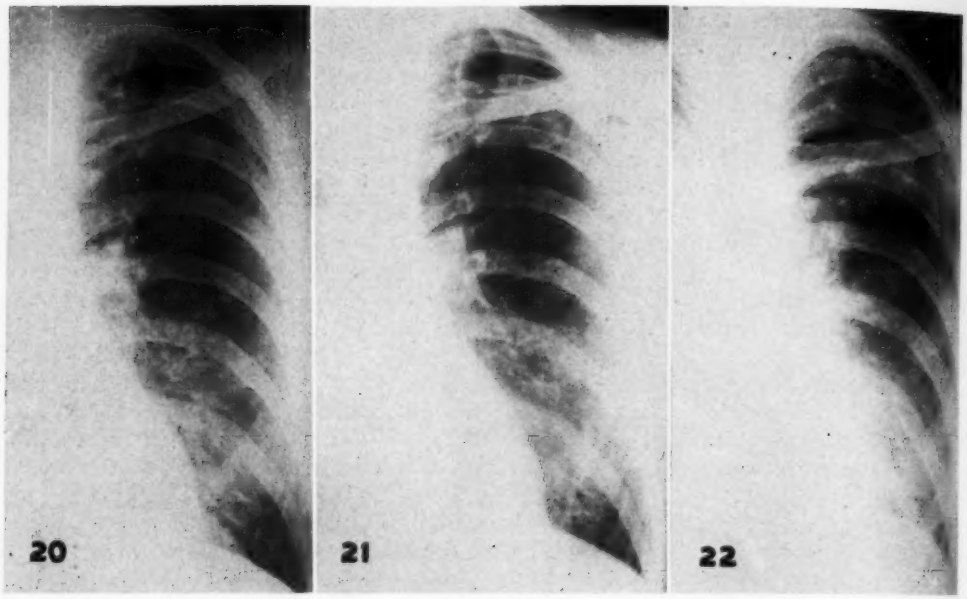


Figs. 17 and 18. Case 8. Fig. 17 (Jan. 12, 1946). Small coalescent exudative-productive lesion at right apex. Fig. 18. Later film (March 18, 1946) showing apparent cavity in right apex (see also Fig. 19).

genogram. (There was no record of a sputum examination before admission.) The clinical history, therefore, is important and can help to evaluate prognosis and guide the patient's progress and treatment.

Case 8 (N. Y., 16-year-old white male): Figure 17 (Jan. 12, 1946) shows a small, coalescent exudative-productive lesion in the right apex. The diagnosis had been made by routine roentgenographic contact examination (father and sister had tuberculosis) in May 1945. The patient was asymptomatic at the time of admission to the sanatorium. Within two months (Fig. 18, March 18, 1946), a rapid change had taken place and a thick-walled cavity was apparently present in the right apex, overlying the first anterior rib. A lordotic apical view (Fig. 19) of the same date more clearly demonstrates the cavity. In this case there were no symptoms to act as a possible guide to the activity of the lesion. The laboratory findings were of value,

Fig. 19. Case 8. Lordotic apical view of same date as Fig. 18 (March 18, 1946). The right apical cavity is clearly outlined.



Figs. 20–22. Case 9. Fig. 20 (April 21, 1943). Round focus in left first interspace. Fibro-calcific lesions at left apex. Fig. 21. Film obtained seven months later (Nov. 26, 1943), showing that the round focus has excavated and formed a thin-walled cavity. Less than three months after this a further film (Fig. 22, Feb. 18, 1944) shows the cavity has filled and closed to form a small round focus again.

however, for although sputum concentrates and gastric concentrates were negative, gastric cultures were positive in August 1945 and in January and March 1946. The sensitive cultures, therefore, served as an indication of the instability of the lesion. With close roentgenographic observation, it was possible to discover the progression of the lesion without delay. Without frequent x-ray study and complete laboratory work, the results could have been disastrous. In other words, had the film of Jan. 12, 1946, (Fig. 17) been considered stable and a follow-up roentgenogram not scheduled for a period of three, six, or more months, an extensive spread might have occurred. As it was, the progression was discovered early, treatment was instituted before more serious complications occurred (pneumothorax was initiated April 1, 1946, and an intrapleural pneumonolysis was done May 18, 1946), and at an optimum time for good results. A selective collapse was obtained (gastric cultures became negative by July 24, 1946), and the patient was discharged as an arrested case, with a daily work tolerance of four hours on April 28, 1947.

Case 9 (H. S., 32-year-old white male): The onset of illness in this case was in August 1941, with streaking. Figure 20 (April 21, 1943) shows a few fibro-calcific nodules and linear productive lesions present in the left apex. A round, homogeneous, dense, hard focus is visible in the lateral portion of the left first anterior interspace and at the level of the 6th posterior rib. The total extent of the lesion is within the minimal classification. The sputum was negative at this time, but it had been positive in the previous year. The roentgenographic picture remained unchanged until seven months later (Nov. 26, 1943). Then, as seen in Figure 21, the round focus was excavated and appeared as a thin-walled circular cavity. The sputum became positive for tubercle bacilli at this time and remained positive for the next three months. A left pneumothorax could not be instituted. A left thoracoplasty

was refused by the patient, and a left phrenic crush was performed Dec. 21, 1943. In Figure 22 (Feb. 18, 1944) the cavity is no longer visible and in its place is a round focus, apparently the filled cavity with the contents inspissated. This round density is smaller in size than the original one (Fig. 20). Sputum and gastric concentrates and cultures remained negative for five months, after which the patient left in an apparently arrested status.

On the basis of the first film (Fig. 20), the lesion was considered minimal. It is true that it meets the criteria of the National Tuberculosis Association as regards the anatomical extent of minimal lesions, but from the standpoint of type of infiltration it may not be minimal. As stated above, in describing Case 4, a solid-looking round focus frequently represents an inspissated cavity. (A check of the history of this case revealed that two years prior to this film, the patient was told he had a cavity in the left upper lobe.) One might, on the basis of this first film, and because of the negative sputum and lack of symptoms, conclude that the lesion was a stable one. But, as already emphasized, the round focus requires close observation and frequent roentgenograms because of the possibility of cavitation and progression. In this patient the round focus excavated and then the cavity filled and closed to form a round focus again. Without close roentgenologic check-up, the appearance of cavitation would have been unknown, progression or hemorrhage could have occurred, and extensive tuberculosis resulted, with delay in control of the lesion. As it was, treatment was not delayed, the cavity was closed, and complications were avoided. In this patient there were no constitutional symptoms at the time of the roentgenographic change to cavitation, but the sputum did become positive at the time of cavitation and negative when cavity closure occurred.

COMMENT

A series of cases has been presented to illustrate the problems associated with the roentgenologic interpretation of minimal pulmonary reinfection tuberculosis. Complete and adequate visualization of the lesion is important to determine the character of the infiltration (Cases 1 and 2). This may require special roentgenographic views or positions. Uniform exposure and film developing factors are also helpful.

The classification of the roentgen picture on a pathological basis is not entirely satisfactory. This is due first to the personal variations in interpretation of the character of the lesion. Moreover, it is not always possible to place the lesions in one category because frequently a mixed type of infiltration is present There are also great differences in correlation between the pathological terms used in describing the films and the actual type of infiltration present in the lungs. Medlar *et al.* (8) have emphasized the difficulties in the use of pathological terms in describing roentgenograms. A comparative study was made by these investigators of the pathological findings and of roentgenograms of the thorax and of inflated excised lungs in miliary pulmonary tuberculosis in the rabbit. It was found that dense, noncaseous, caseous, caseo-fibrotic, and fibrotic areas could not be differentiated in roentgenograms of inflated excised lungs. Medlar comments: "It is a very common practice for interpreters of roentgenograms of the chest to use such pathological terms as fibrotic, fibro-caseous, calcified, productive, and exudative, etc. From our experimental study it seems doubtful, except in instances where considerable calcified deposits are present, that such pathological interpretations are correct when shadows seen in single roentgenograms of a chest are interpreted. When serial roentgenograms are available, such interpretations may be allowable provided that it is remembered that readings are based upon inference and not upon shadow characteristics that are pathognomonic of the lesions interpreted. We suggest it would be a better practice if interpretation of intrathoracic shadows observed in roentgenograms of the chest are limited to descrip-

tions of the location, extent of distribution and density of shadows, and to forego any pathological interpretation until a satisfactory classification has been evolved which will clearly differentiate the processes mentioned above." It is apparent that it will require a good deal of study and correlation between necropsy material and roentgenological findings in human tuberculosis to help put roentgenologic terminology on a more solid footing.

We found it a very hazardous procedure to attempt to decide the prognosis or clinical significance of a lesion on the basis of one film (or a few films). It is impossible to know what has happened, or to have an accurate conception of the initial or previous type of pulmonary infiltration, or to predict the future behavior of the lesion from one roentgenogram. The antecedent lesion, or final appearance of the infiltration, may be very different from that observed on a single examination. Cases 3, 4, and 5 (with antecedent cavernous lesions) and Case 6 (with previous moderately advanced, non-cavernous infiltration) illustrate that it is unwise to assume, when interpreting a film with a minimal lesion, that the infiltration was always minimal, unless all the films are available. A minimal lesion can, therefore, best be evaluated if the whole history of the case is known, and it would be necessary to have all the roentgenograms from the time of diagnosis. The other films will often show many changes, either regressive or progressive, making it easier to interpret and prognosticate from the one on hand. Treatment can also be more accurately guided with complete serial observation and knowledge of all the changes in the development of the lesion. With a thorough roentgenographic study, one can appreciate the possible or potential pathogenetic changes in the type of lesion (minimal from onset, or minimal residuum of an advanced lesion, cavernous or non-cavernous) and more easily explain the changes that occur. The serial study also indicates the ability of the patient to heal his tuberculosis and the type or end-stages of healing, which are important in evaluation of the lesion. If serial roentgenograms are not available, the outcome can be predicted only on the possibility that certain changes have taken place in the past, and close observation should be provided for the patient.

We have emphasized the problems inherent in judging clinical activity and prognosis on the basis of the roentgenogram. Yet there is a need to classify and properly advise patients with abnormal x-ray shadows. The present roentgen classification with the use of pathological terms (exudative, exudative-productive, productive-fibrotic, fibro-calcific), though not satisfactory in every respect, is the best practical classification available at present. It should be used, however, with an appreciation of its limitations and shortcomings.

There is also need for close and constant follow-up in minimal cases, since the infiltration (as illustrated in Cases 7, 8, and 9) can change rapidly and to a considerable degree. Caseation and cavitation can occur within a short time from a small lesion. This is especially important during the first two or three years after diagnosis. In our study of minimal tuberculosis (2), it was found that most progressions occurred during the first two years of follow-up observation, with the highest progression rate in the second year and a risk of some importance present in the third year, but not after that. When the diagnosis is made by routine radiography as in mass x-ray surveys, with no previous films available for comparison or study, the individual must be re-checked frequently and the observation should not be discontinued until a considerable period of time has elapsed.

The roentgenogram is only part of the evidence to be considered with other data (the clinical condition, symptomatology, physical examination, and bacteriological findings) in complete and proper interpretation of the case. For example, in Case 7 the symptoms indicated tuberculous activity, and in Case 8 the bacteriological findings meant instability of the lesion. This

type of information can help in evaluation of the prognosis and significance of the lesion. Moreover, untoward progression can be usually avoided by such careful observation. Treatment that is required can be initiated without delay and before complications have occurred that will diminish the chances of therapeutic success.

Pulmonary lesions may be minimal in extent yet represent the end-result of tubercu ous cavity closures. Linear horizontal scars (Case 3), round foci (Cases 4 and 9), and stellate scars (Case 5) are examples of this type which may be incorrectly interpreted as minimal lesions with a good prognosis. Because of the antecedent cavernous process, the possibilities of reopening of the cavities and progression of the disease exist. The linear scar and round focus provide a more characteristic roentgenographic appearance than the stellate scar, though all of these lesions are in a special category and must be carefully watched. In classifying the minimal lesions by type of infiltration, it might be of practical value to note the presence of these more special lesions, as an indication of cavitation, recent or old.

A more uniform roentgenologic interpretation of minimal tuberculosis might be possible if, in the National Tuberculosis Association classification, it were required to state the total length of observation of the case and whether the evaluation is made on the basis of a series of films, a few films, or one film. It would also be helpful to state the length of time between the onset of the illness and the date of the film where possible.

CONCLUSIONS

1. Before an attempt is made to interpret an individual roentgenogram, the lesion should be visualized completely and satisfactorily. Special roentgen views may be necessary for this purpose. These additional studies may also reveal cavernous lesions considered minimal on routine films.

2. The placement of lesions in one of four different categories (exudative, exudative-productive, productive-fibrotic, and fibro-calcific) is not an easy matter. Considerable differences of opinion exist in film interpretation.

3. The discrepancies between the pathological terms used for roentgenologic description and the actual infiltration and behavior of the lesion have been discussed.

4. The hazard of attempting to interpret minimal lesions on the basis of one film has been illustrated.

5. The need for a complete roentgenographic series of examinations in each case and close follow-up has been emphasized.

6. Cases with rapid changes in minimal infiltrations have been shown. The transition of tuberculous cavities into lesions of minimal extent in the form of a linear fibrotic scar, stellate scar, or round focus has been demonstrated.

Municipal Sanatorium
Otisville, N. Y.

REFERENCES

1. REISNER, D., AND DOWNES, J.: Minimal Tuberculous Lesions of the Lung. Am. Rev. Tuberc. **51:** 393–412, 1945.

2. BOBROWITZ, I. D., HURST, A., AND MARTIN, M.: Minimal Tuberculosis. Am. Rev. Tuberc. **56:** 110–125, 1947.

3. BIRKELO, C. C., CHAMBERLAIN, W. E., PHELPS, P. S., SCHOOLS, P. E., ZACKS, D., AND YERUSHALMY, J.: Tuberculosis Case Finding; Comparison of Effectiveness of Various Roentgenographic and Photofluorographic Methods. J. A. M. A. **133:** 359–366, 1947.

4. CORYLLOS, P. N.: Mechanics and Biology of Tuberculous Cavities. Am. Rev. Tuberc. **33:** 639–660, 1936.

5. TCHERTKOFF, I. G., AND BOBROWITZ, I. D.: Spontaneous Closure of Tuberculous Pulmonary Cavities. Quart. Bull. Sea View Hosp. **1:** 173–188, 1936.

6. TAYLOR, H. K., AND BOBROWITZ, I. D.: Use of Watery and Oily Contrast Substances in Pulmonary Tuberculosis. Quart. Bull. Sea View Hosp. **1:** 82–88, 1935.

7. BOBROWITZ, I. D.: The Round Pulmonary Tuberculous Focus. Am. Rev. Tuberc. **47:** 472–483, 1943.

8. MEDLAR, E. M., PESQUERA, G. S., AND ORDWAY, W. H.: A Comparison of Roentgenograms with the Pathology of Experimental Miliary Pulmonary Tuberculosis in the Rabbit. Am. Rev. Tuberc. **50:** 1–23, 1944.

(For Spanish summary, see following page)

SUMARIO

Tuberculosis Mínima

Al discutir los problemas comprendidos en el diagnóstico roentgenológico de las lesiones tuberculosas mínimas del pulmón, preséntanse casos que las ilustran. La visualización completa y adecuada es lo primero para determinar la naturaleza de la infiltración. Por ej., en los Casos 1 y 2, las vistas del vértice demarcaron claramente procesos que no reveló en forma adecuada el examen corriente.

Recálcase la importancia de las radiografías seriadas. Una lesión antecedente puede ser muy distinta de la infiltración observada en un examen aislado realizado en una etapa más tardía de la evolución de la dolencia. Una inspección de las radiografías anteriores puede que revele que una lesión aparentemente mínima en forma de cicatriz fibrosa lineal (Caso 3), foco redondo (Caso 4) o cicatriz estrellada (Caso 5) representa realmente antiguas cavernas tuberculosas. Igualmente, una previa lesión no cavernosa puede más tarde tomar el aspecto de enfermedad mínima primaria (Caso 6).

También se necesita una cuidadosa y constante observación subsiguiente en los casos mínimos, pues la infiltración puede mostrar rápido avance (Casos 7–9). Esto reviste importancia sobre todo en los primeros dos años de observación, por haberse notado que la mayor parte de los avances corresponden a dicho período.

Los AA. discuten las dificultades que entraña la clasificación de las lesiones en las cuatro categorías: exudativa, exudativa-productiva, productiva-fibrosa y fibrocalcificada. En el problema de la interpretación intervienen variaciones personales, existen lesiones de forma mixta y los términos patológicos no son idealmente adaptados para la descripción del aspecto radiográfico.

Radium Therapy in Carcinoma of the Female Urethra[1]

ROBERT E. FRICKE, M.D.
Section on Therapeutic Radiology, Mayo Clinic
and
JAMES T. McMILLAN, M.D.
Fellow in Radiology, Mayo Foundation
Rochester, Minn.

CARCINOMA OF THE female urethra is an uncommon but important disease. Its uncommonness is indicated by the small number of cases appearing in the literature. In 1933, Counseller and Paterson (1) found only 124 cases reported. To this number they added 12. In 1935 Menville and Counseller (2) estimated that a total of 149 cases had been published. Sparks and Parsons (3), in 1937, reviewed 119 cases and found references to 49 others. Nichol (4) stated that up to 1940 reports of 262 examples were available for study in the literature. The disease is important because, as is true of all carcinomas, if it is not discovered and adequately treated early, the outcome will be fatal.

REVIEW OF LITERATURE

The principal articles reviewing large numbers of cases have already been mentioned. Further reference to them will be brief.

Most authors mention the first case of carcinoma of the female urethra reported in 1833 by Mme. Boivin (5). In an early report by Shaw (6), in 1923, the methods of treatment were discussed. At that time treatment was mainly surgical, but Shaw reported 2 cases in which he had used radium. In their report of 12 cases from the Mayo Clinic in 1933, Counseller and Paterson concluded that the best results were obtained when radium or roentgen therapy was used in conjunction with surgery.

Menville (7), in 1935, stated that in 109 cases the average age at the time of diagnosis was 53.4 years. He found that most of the patients were married and multiparous; the average number of children per patient was five. He also noted that the majority of lesions were located in the anterior urethra only, or extended over the entire urethra. In the 119 cases collected from the literature by Sparks and Parsons, the average age at onset was 54 years. Of this group, only 15 patients survived three or more years after treatment. Of the 39 patients treated by surgical means alone, only 2 lived as long as three years. Of 40 treated by radium or roentgen rays alone, 6 lived three years or longer. Twenty-one patients received radium or roentgen irradiation in addition to surgery, and among these there were 7 three-year survivals. Nichol, in 1941, reported 2 cases of carcinoma of the female urethra in addition to the 262 cases which he was able to find in the literature up to that time. In 1945, Clayton (8) stated that leukoplakia and caruncle did not seem to be precursors of carcinoma of the urethra. He divided the lesions into urethral and vulvo-urethral types and noted that there were enlarged inguinal nodes in 20 per cent of cases. He also pointed out the need for individualization in treatment.

ANATOMY AND LOCATION OF LESIONS

The female urethra is about 3 to 4 cm. in length (9). It begins at the neck of the bladder, opposite about the middle of the symphysis pubis, and courses downward and forward anterior to the vaginal wall. For descriptive purposes the urethra is divided into a meatal portion, which we call the proximal portion (because it is closer to the examiner), and a posterior or

[1] Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

distal portion. Proximal and distal are used in that sense in the following paragraphs.

The distal segment of the urethra is surrounded by fibers of the sphincter urethrae muscle; in its proximal segment it becomes embedded in the anterior vaginal wall. The smooth muscle coats consist of an outer circular and inner longitudinal layer. Toward the meatus, the smooth muscle is strengthened by a striated muscle sphincter. At the proximal end, the muscle is largely replaced by fibrous tissue, which gives firm prominent margins to the external orifice. The submucous layer is mainly vascular areolar tissue. The mucous layer lies in longitudinal folds and contains the mucous glands. The mucous coat is lined with stratified squamous epithelium (10).

The lymphatics are arranged similarly to those of the prostatic and membranous portions of the male urethra, which are the homologues of the female urethra. The collecting lymphatic trunks terminate in the anterior or medial retrofemoral nodes, the external iliac, hypogastric, and sacral nodes (11).

The proximal half of the urethra is most frequently the site of carcinoma, but any part or all of the organ may be involved. The lesions may be polypoid, ulcerated, or infiltrating in gross appearance. Early in the course of the infiltrating lesions there will be extension to the anterior vaginal wall, so that involvement of inguinal nodes may be expected, as well as of the nodes which drain the urethra itself. As the disease progresses, the bladder may become involved by direct extension, and vesicovaginal fistulas may occur. Involved inguinal nodes may suppurate and drain. Distant metastasis may occur.

PRINCIPLES OF TREATMENT

Any tumor which is as variable in its gross appearance and extent at the time of recognition as is carcinoma of the female urethra will naturally be treated in many different ways. For the same reason, no one physician will be able to use the same method in all his cases. Therapeutic measures may be divided into four general types: cautery, excision, radium therapy, and roentgen therapy. The smaller the tumor, and the more it is confined to the proximal portion of the urethra, the more applicable are cautery and excision in the treatment. On the distal part of the urethra these methods can be used only at the cost of permanent incontinence. Radiation therapy may be given in conjunction with cautery and excision, although in advanced lesions irradiation is usually employed alone. Various types of radiation may be used. Radon seeds or radium needles may be implanted into the tumor. Radium tubes may be placed inside the urethra, or inside the vagina, either in contact with the anterior vaginal wall or in a vaginal applicator. Intravaginal roentgen therapy has been used by Jackman and Bacon (12). Combinations of these different methods are usually employed. Involved inguinal nodes may be treated by excision or irradiation. Taussig (13) favored radium treatment of the urethral lesion followed by the Bassett operation for removal of inguinal and femoral nodes in favorable cases. Others have preferred radium or roentgen therapy for the inguinal nodes. Roentgen therapy is also used for pelvic extensions of the lesion.

It would be desirable to express in gamma roentgens the amount of gamma radiation necessary to control these tumors. However, again the great variability in technics makes this impracticable.

THE PRESENT SERIES

The present series includes all cases of carcinoma of the female urethra in which treatment with radium was given at the Mayo Clinic from 1918 through 1942. We have included in this group cases in which the clinical diagnosis was carcinoma. The diagnosis at biopsy is given ater. Radium was used either alone or in conjunction with other forms of therapy. The total number of cases is 35. Six of the 12 cases reported by Counseller and Paterson in 1933 and the case reported by Menville

and Counseller in 1935 are included in the series. In 13 (37 per cent) of the 35 cases some form of treatment was given before the patient came to the Clinic and, therefore, these cases are called modified. The average age of the patients was 52.4 years. The distribution by decades is shown in Table I.

TABLE I: AGE DISTRIBUTION

Age (years)	Number	Per Cent
30–39	5	14.3
40–49	5	14.3
50–59	18	51.4
60–69	5	14.3
70–79	2	5.7
TOTAL	35	100.0
Mean age	52.4 years	

The chief symptoms which were reported by the patients were dysuria, a mass at the external meatus, frequency, and bloody vaginal discharge in that order. Various other symptoms, such as hematuria, retention of the urine, incontinence, and dyspareunia, were mentioned less frequently.

Most of the lesions were located in the proximal portion of the urethra, although in some of the more advanced cases the entire urethra was involved. All of the lesions appeared to be infiltrating, and some of them were ulcerated. Because of this tendency to infiltration, the anterior vaginal wall was involved in many of the cases, as would be expected from the anatomy of the region. Polypoid growths at the meatus must be regarded with suspicion when a diagnosis of carcinoma is suggested, for they are more frequently benign. Carcinomas *in situ* cannot be included in a discussion of ordinary carcinomas, for they are not clinically malignant. After studying the microscopic sections, we discarded 3 cases which we originally planned to include in our series. In 2 of these 3 cases the polypoid lesions proved not to be carcinomas, and in the third case a carcinoma *in situ* was present.

In all except 5 of the 35 cases included, biopsy was performed and a microscopic diagnosis was made. These diagnoses are given in Table II. In the earlier years, biopsy was sometimes omitted in cases in which the lesion was obviously malignant clinically. We believe that it is justifiable to include in this series the 5 cases in which biopsy was not done and the 2 others in which the tissue was reported as inflammatory, because of the clinical evidence of malignancy in these cases. Of the remaining cases, 24 were squamous-cell epitheliomas, in 21 of which the grade of malignancy was determined (Broders' method).

TABLE II: RESULTS OF BIOPSY IN 35 CASES OF THE CLINICALLY MALIGNANT LESIONS OF THE FEMALE URETHRA TREATED WITH RADIUM

Squamous-cell Epithelioma	Cases
Ungraded	3
Grade I	0
Grade II	6
Grade III	10
Grade IV	5
TOTAL	24
Other Diagnoses	
Inflammatory lesion	2
Malignant tissue	1
Mucoid carcinoma, grade IV	1
Carcinoma	1
Melanoepithelioma	1
No biopsy	5
TOTAL	11
GRAND TOTAL	35

In 26 of the 35 cases, enlargement of the inguinal lymph nodes was present. This finding was interpreted clinically as malignant involvement, although it was proved microscopically in only a few cases. As already stated, involvement of the inguinal nodes by the malignant process indicates that the tumor has infiltrated into the anterior vaginal wall.

No definite therapeutic routine was followed in these cases. Treatment is limited, of course, by the quantity of radiation to which the surrounding tissues can be exposed and still recover. A further limitation is the desire to maintain the function of the urethra. In general, three different methods of applying radium or radon were employed. First, interstitial implants of radon or interstitial radium needles were used. Second, contact therapy was employed, that is, the radium or radon tubes were placed directly against the lesion, either by an intra-urethral ap-

TABLE III: CARCINOMA OF THE FEMALE URETHRA: FIVE-YEAR AND TEN-YEAR SURVIVAL RATES ACCORDING TO TYPE OF TREATMENT

Type of Treatment	Patients*		Lived 5 or More Years After First Treatment		Patients*		Lived 10 or More Years After First Treatment	
	Total	Traced	Number	Per Cent of Traced Patients	Total	Traced	Number	Per Cent of Traced Patients
Radium	14	13	2	15.4	14	12	1	8.3
Radium and roentgen rays	10	10	5	50.0	7	6	3	50.0
Excision and radium	9	9	7	77.8	7	7	4	57.1
Excision or cautery or both, and radium and roentgen rays	2	2	1	50.0	2	2	1	50.0
TOTAL	35	34	15	44.1	30	27	9	33.3

* Inquiry as of Jan. 1, 1948. Included in the five-year group are those patients who were first treated five or more years prior to the time of inquiry, that is, 1942 or earlier; the ten-year group includes only those patients first treated in 1937 or earlier.

proach or through the anterior vaginal wall. Third, by the use of a vaginal applicator, radium at a distance of 1 cm. was directed at the lesion. Treatment of the metastatic lymph nodes was by radium or roentgen therapy. Excision or cautery destruction of an early circumscribed lesion may be desirable prior to the application of the radium. In this series, roentgen therapy was used only for the treatment of inguinal nodes or for general irradiation of the pelvis in cases of advanced carcinoma.

The different combinations of treatment fall into four groups in our cases. Fourteen patients had radium treatment alone. Ten had radium and roentgen therapy. Nine had excision with or without cautery in addition to radium. Two were treated by excision or cautery or both and by radium and roentgen therapy. The results of these different combinations of treatment appear in Table III.

Fifteen (44.1 per cent) of the 34 traced patients survived five years or more after the diagnosis was made at the Clinic. Of the 13 traced patients who received radium therapy alone, only 2 survived five years. Of the 10 patients who had radium and roentgen therapy 5 lived five years or more. Of the 9 who had surgical treatment and radium, 7 lived five years or more, and of the 2 who had surgical treatment with radium and roentgen therapy 1 survived five years. Thirty patients had received their first treatment in 1937 or earlier. Twenty-seven were traced for ten years or more. Nine of these patients were still living after that interval. The best results were obtained in the group of patients who were treated by surgical means and radium. This is what would be expected, as this group consisted of those with the earliest and most localized lesions. The poorest results occurred in the group in which radium therapy alone was used, but this was the group which contained the most advanced cases and in which the treatment was usually considered a palliative procedure.

Some complications followed the radium treatment of these lesions. The formation of scar tissue and the resultant strictures may make subsequent dilatations of the urethra necessary. If the muscle fibers of the distal urethra are destroyed, incontinence may result. Fistulas between the urethra and vagina or between the bladder and vagina may develop, but these are frequently the result of the disease process itself rather than the therapy.

For the purpose of giving more specific information as to how some of the cases were managed, we present two histories.

REPORT OF CASES

CASE 1: The patient, whose age was 59 years, complained of soreness at the urethral meatus and dysuria for three months. Three weeks before she registered at the Clinic, biopsy of the lesion had revealed a squamous-cell epithelioma, grade III.

On examination at the Clinic, Aug. 29, 1938, a thick, raised, reddened growth extending about 1 cm. into the periurethral tissues was observed at the urethral meatus. The previous diagnosis was confirmed. Twelve 1-mg. radium needles were distributed evenly through the tumor and left in place for twenty-four hours. The radium needles had an active length of 0.5 cm. and were filtered by 0.4 mm. platinum. In addition, 120 mc. of radon was applied over the lesion for four and a half hours—three tubes of 40 mc. each, 1.0 cm. in active length, with 0.5 mm. silver and 1.0 mm. brass filtration. Further filtration was afforded by covering the tubes with 2.0 mm. of soft rubber. They were inserted into the vagina near the lesion and held in place by gauze packing. On Sept. 12, 1941, a small mass which had been present in the left groin for three weeks was excised and proved to be squamous-cell epithelioma, grade IV. Roentgen therapy was given to the left groin and posterior part of the pelvis. In 1940 and 1941, the urethra and bladder appeared normal on cystoscopic examination. In November 1942, a doctor in the patient's home locality reported that she had no symptoms and there was no palpable inguinal adenopathy. A letter from the patient on June 6, 1948, stated that she had had no further trouble and was in good health.

CASE 2: This patient, aged 33 years, was first seen at the Clinic on July 28, 1937. She complained of pain on intercourse for one and a half years and dysuria for three to four weeks. She had also had a slightly bloody vaginal discharge for two months. Examination revealed a hard mass, measuring 2 × 3 × 2 cm., surrounding the urethra. There were enlarged inguinal nodes bilaterally. Biopsy of the urethral mass revealed squamous-cell epithelioma, grade III. Seventeen 1-mg. radium needles (the same specifications as mentioned in Case 1) were inserted evenly throughout the lesion and left in place for seventy-two hours. In addition, 102 mc. of radon distributed in three tubes (same specifications as in Case 1) were placed in the vagina near the urethra and held in place by means of a dental mold. These tubes were left in place for five and a half hours. The groins were also treated with radium. The patient was last seen at the Clinic in September 1947, at which time no tumor was present. A urethral stricture necessitated dilatation.

SUMMARY

A review of the literature reveals that carcinoma of the female urethra is relatively uncommon. The anatomy and lymphatic drainage of the female urethra are discussed.

Thirty-five cases of carcinoma of the female urethra in which treatment with radium was given at the Mayo Clinic from 1918 through 1942 form the basis for this paper. The method of treatment which gave the best five-year survival was a combination of excision or cautery destruction with radium therapy.

The technic of treatment in 2 cases is described.

The average age of the 35 patients at the time the diagnosis was made at the Clinic was 52.4 years. A majority of the lesions were squamous-cell epitheliomas. Fifteen (44.1 per cent) of the 34 traced patients survived five years or more after treatment was started.

The Mayo Clinic
Rochester, Minn.

REFERENCES

1. COUNSELLER, V. S., AND PATERSON, S. J.: Carcinoma of the Female Urethra. J. Urol. **29:** 587–595, May 1933.
2. MENVILLE, J. G., AND COUNSELLER, V. S.: Mucoid Carcinoma of the Female Urethra. J. Urol. **33:** 76–81, January 1935.
3. SPARKS, T. P., JR., AND PARSONS, W. H.: Carcinoma of the Female Urethra: Case Report with Summary Review of the Literature. Urol. & Cutan. Rev. **41:** 157–163, March 1937.
4. NICHOL, J. E.: Two Cases of Carcinoma of the Urethra. Canad. M. A. J. **45:** 155–156, August 1941.
5. BOIVIN, M. A. V. G.: Quoted by Clayton, S. G. (8).
6. SHAW, W. F.: Carcinoma of the Female Urethra, with Notes of Two Cases Treated with Radium. J. Obst. & Gynaec. Brit. Emp. **30:** 215–219, 1923.
7. MENVILLE, J. G.: Primary Neoplasms of Female Urethra. Surg., Gynec. & Obst. **61:** 229–238, August 1935.
8. CLAYTON, S. G.: Carcinoma of the Female Urethra (Review of the Literature and Report of Three Cases). J. Obst. & Gynaec. Brit. Emp. **52:** 508–512, October 1945.
9. Cunningham's Manual of Practical Anatomy. Edited by J. C. Brash and E. B. Jamieson, New York, Oxford University Press, 10th ed., 1940, Vol. 2, 500 pp.
10. MAXIMOW, A. A., AND BLOOM, W.: A Textbook of Histology. Philadelphia, W. B. Saunders Company, 2nd ed., 1934, pp. 484–487.
11. ROUVIÈRE, H.: The Lymphatics of the Urinary System. In Anatomy of the Human Lymphatic System, translated by M. J. Tobias. Ann Arbor, Mich., Edwards Brothers, Inc., 1938, pp. 209–217.
12. JACKMAN, J., AND BACON, R. D.: Radiation Treatment of Carcinoma of the Female Urethra. Pennsylvania M. J. **49:** 518–519, February 1946.
13. TAUSSIG, F. J.: Primary Cancer of the Vulva, Vagina and Female Urethra: Five Year Results. Surg., Gynec. & Obst. **60:** 477–478, February 1935.

(For Spanish summary and discussion see following page)

SUMARIO

Curieterapia en el Carcinoma de la Uretra Femenina

Según revela un repaso de la literatura, el carcinoma de la uretra femenina es relativamente raro. La serie aquí comunicada comprende todos los casos de carcinoma uretral en la mujer, tratados con radio en la Clínica Mayo desde 1918 hasta 1942 inclusive. La mayor parte de las lesiones radicaban en la porción proximal o meatal de la uretra, aunque en algunos casos avanzados estaba afectado todo el órgano. Todas parecían ser infiltrantes y algunas eran ulceradas. Los ganglios linfáticos inguinales estaban infartados en 26 casos. La mayoría de los tumores eran epiteliomas escamocelulares. La edad de las enfermas promediaba 52.4 años. Catorce de ellas recibieron solamente la curieterapia; 10, la curie y la roentgenoterapia. En las demás, se combinó la irradiación con el radio solo o con el radio y los rayos X con la excisión o la cauterización o con ambas.

Quince (44.1 por ciento) de las 34 enfermas seguidas sobrevivieron cinco años o más después de hacerse el diagnóstico. De 30 tratadas en 1937 o antes, 27 fueron seguidas diez años o más, y 9 de ellas estaban todavía vivas. Los mejores resultados fueron obtenidos en el grupo tratado con la cirugía y el radio, aunque se hace notar que este grupo contenía los casos más favorables. La técnica terapéutica empleada en dos casos aparece descrita.

DISCUSSION

Frank Hinman, Jr. (San Francisco): Drs. Fricke and McMillan have given us what we have come to expect from the Mayo Clinic, a comprehensive paper on a large number of cases with commendable therapeutic results. However, their approach as radiologists is, from the point of view of the genito-urinary surgeon, a rather special and restricted one, so that complete agreement with all their conclusions is not possible.

The authors have, of course, so selected their cases as to omit those treated exclusively by the surgeon, yet it is a comparison of cases treated by radical surgery with those treated by radiotherapy that would seem to be most profitable to both the urologist and the radiologist. It has been estimated by many students of the disease that from 12 to 73 per cent of cases have metastasis to the inguinal nodes when treatment is begun—Göbel and Hamann (1937), 12 per cent; Walker and Clayton (1945), 20 per cent; Ehrendorfer (1899), Shaw (1923), von Mikulicz-Radecki (1931), Auer (1935), and Lazarus and Schneider (1936), 33 per cent; Watson (1936) 41 per cent, and, highest of all, 73 per cent of the cases described in this present paper. Moreover, Taylor and Nathanson (1942) in their book on lymph node metastasis state that bilateral involvement is common and must be assumed to be present. If metastatic carcinoma is found in such a high percentage of cases, the main point for discussion of cures is the method of treatment of the possibly involved inguinal and femoral nodes; it would not seem to make much difference what is done to the primary site if these peripheral involved areas are not adequately treated.

The authors, understandably, first, have observed poor results from radium alone since, as they state, it was often used in late cases and could not affect the metastases; second, have seen fair results following x-irradiation to the inguinal and femoral regions in addition to local treatment; and finally, have found their best results in a selected (but statistically inadequate) group of early cases in which excision and local radium therapy were deemed adequate.

TABLE I

(From Taussig, F. J.: Surg., Gynec. & Obst. 60: 477, 1935)

Treatment	Number	Dead	Alive 5 Years
Radiation	8	7	1 (12%)
Local excision	1	1	0 (0%)
Local excision plus radical node dissection	3	0	3 (100%)
No treatment	2	2	0 (0%)

Of the two methods of local treatment, complete resection of the urethra or local excision of the tumor with implantation of radium, the urologist would usually choose the latter. However, the question that is foremost in his mind is not this choice, but the decision between local treatment with (as publicized by von Mikulicz-

TABLE II

(From Auer, E. S.: Am. J. Obst. & Gynec. **30:** 318, 1935)

Treatment	Number	Dead	Alive 5 Years
Local only	14	8	2 (14%)
Local + Bassett	6	1	3 (50%)
None	2	2	0 (0%)
	22	11	5 (23%)

Radecki) or without radical groin dissection. Two series published some years ago (1935) give one answer to this question. Taussig (Table I) obtained by far the greatest percentage of five-year cures by local treatment plus radical groin dissection, while Auer (Table II) obtained similar though less spectacular results with local treatment in conjunction with the Bassett groin dissection. It is our opinion that x-ray therapy should not be depended on for the treatment of inguinal node involvement, but rather, unless the carcinoma is definitely inoperable, a bilateral radical groin dissection of the inguinal, femoral, and external iliac nodes should be undertaken. This is the accepted procedure for carcinoma of the penis, which has a similar lymphatic drainage, and it is difficult to see why an entirely different approach to treatment must be undertaken in the female.

If the nodes are not enlarged but the lesion has palpably penetrated the urethral wall and involved the periurethral lymphatics and those of the vagina, then also we feel that wide resection of the local tumor with radical node dissection is necessary if cure is to be accomplished, even if this means transplantation of the ureters. We would be satisfied with radiation therapy alone, with or without local excision, only if the lesion were very small, on the one hand, or quite inoperable, on the other.

George Sharp, M.D. (Pasadena, Calif.): Dr. Fricke certainly has brought to our attention this morning a very historical group, may we say—cases that are rare in their occurrence and covering a period of some four decades. It might have been well if he had selected a characteristic case from each of these decades, illustrative of the radiation technic at the time. May I ask him in his discussion if he will give us briefly his present outline of radiation therapy for a moderately advanced cancer of the urethra. This calls to mind the papers so far presented in this program on cancer of the cervix. We have heard literally of four different methods of radiation therapy, and there may be still further procedures to come. This suggests the fact that the radiation procedures are individualized not only so far as the patient is concerned, but they must also be individualized so far as the radiologist carrying out the treatment is concerned.

A breakdown of any series of rare cases like this over such a long period is really impossible, but there are two or three points that are of considerable interest to me. I am sure that the seven cases treated by surgical excision were in the earliest group. Naturally we would wish that there were many more such cases. These early cases might, of course, equally well be treated by roentgen therapy. I think the most interesting group of Dr. Fricke's series is that made up of what he calls moderately advanced cases of cancer of the urethra, which were treated by roentgen and radium therapy—10 cases. We must assume growths, say over 2.0 cm. in diameter, and with roentgen and radium therapy a 50 per cent five-year cure rate was obtained. In our recent experience and in the experience set forth in the current literature, there is an increasing interest in roentgen therapy, and it seems to me that the most uniform tissue depth dose might well be gained by roentgen irradiation, with possible substitution of interstitial radium in certain selected cases. Dr. Fricke's two cases illustrate this combined method of irradiation.

Metastatic disease was discussed by Dr. Hinman at some length. We all realize that the clinical interpretation of inguinal nodes is of no value, and that radiation therapy for inguinal nodes is of equally little value. However, in one case of Dr. Fricke's, a squamous-cell Grade 4 cancer in the groin was treated by roentgen therapy alone, and the patient is well after five years. One can't overlook such a case but, by and large, current treatment for metastatic inguinal nodes is a radical groin dissection. During this procedure one has plenty of opportunity to decide whether there is hypogastric or iliac node involvement.

I would like to ask Dr. Fricke how many of his five-year cures had positive metastatic nodes proved by microscopic examination. I think this information would give us some impression at least as to whether or not we should go ahead with these radical groin excisions.

Dr. Fricke (*closing*): I wish to thank the discussants for the salient points they have brought up. We are interested in this group of cases for two reasons: first, because of the fortunate rarity of this lesion; second, because of the difficult therapeutic problems presented. In the choice of treatment—radium, surgery, roentgen rays, or combinations of all of them—the appropriate method should be determined in each case on the basis of the exact location of the lesion, the microscopic grade of the cancer, and the condition of the patient. Also, as brought out by Dr. Cantril in his refresher course this morning, if you are getting good results, and are satisfied with the re-

sults obtained in a particular group of cases by means of a well established technic, it is best to maintain that technic. Dr. Heyman of the Radiumhemmet has stated that the difficulties encountered throughout the world in evaluation of results in cancer of the cervix would be obviated if physicians would adhere as rigidly as they possibly can to the accepted classification, and if gradually improving concepts of treatment were maintained rather than such practices as ranging from one type of treatment to another.

Inguinal node metastases can be sterilized by irradiation. Biopsy always should be carried out. If the metastatic nodes are operable, surgical excision may be preferable to irradiation.

Of course, this problem of cancer of the urethra demands teamwork on the part of the urologist, radiologist, and urologic surgeon.

Carcinoma of the Thyroid Gland[1]

WILLIAM E. HOWES, M.D., and MERRILL N. FOOTE, M.D.,

Brooklyn, N. Y.

BY LOCATION, the thyroid is protected from those extrinsic carcinogenic stimuli which affect surface epithelium. Thyroid tissue may enter into a hyperplastic phase, however, as a result of infection, intoxication, pregnancy, deficiency states (vitamin and mineral), and emotional stress. From a functional standpoint the thyroid gland is in a constant state of flux, in response to physiologic and pathologic stimuli. Continued overactivity results in hyperplasia, which may involve the gland as a whole, as in pregnancy, or may be limited to a single or multiple foci, adenomata. Residua of these hyperplastic centers are carried throughout the life of the individual and are potential sources of neoplastic metamorphosis. In fact, 90 per cent of all thyroid carcinomata have been said to arise in pre-existing adenomata (Portmann, 1).

To function normally, the thyroid requires a minute but constant supply of iodine. In regions where the basic iodine intake is deficient, goiter is more common, and "when goiter is endemic, malignant tumors of the thyroid gland occur in greater numbers" (Wegelin, 2). The proportion of carcinoma in large series of nodular goiters varies from 7.2 per cent (Cole, 3) to 2.5 per cent (Stout, 4). The number of persons in the population having carcinoma of the thyroid gland is in direct proportion to the number having adenomatous changes. Thus in mortality tables for England and Ireland thyroid carcinoma, because of its rarity, has been recorded only under miscellaneous conditions, while in the Swiss vital statistics it is listed as accounting for 1.6 per cent of all carcinoma deaths. In America, ease in transportation of foodstuffs should tend to correct any regional deficiency in iodine intake. Nevertheless, it is well known that goiter is prevalent in areas bordering on the Great Lakes, the so-called "goiter belt," and in part of the state of Washington (Mason, 5), as well as in other widely scattered localities.

The New York City Health Department (6) reports deaths from thyroid carcinoma as representing less than 0.1 per cent of all deaths and only 0.5 per cent of all cancer deaths throughout the greater city from 1944 through 1946. This is in general agreement with vital statistics throughout the nation.

The Brooklyn Cancer Institute, organized at its present location in 1936, may be thought of as something of a pilot plant, set up by the municipality for the study and treatment of malignant disease. With fewer than 80 beds the city can offer care to but a small proportion of the total number of indigent cancer patients of this borough, where there were over 4,700 deaths from cancer during the year 1947. Patients are not only admitted to the Institute *via* the outpatient clinic but are also accepted as transfers from hospitals throughout the greater city. As a result of this policy, the larger number of persons suffering from thyroid cancer, accepted for admission, have the disease in its more advanced stages, *i.e.*, with recurrent tumor (75 per cent of those admitted had had a preceding thyroidectomy) or with metastases.

Patients suffering from obviously nonmalignant conditions of the thyroid gland are not acceptable for admission. But twice in eleven years a thyroidectomy was performed on a supposedly benign adenoma, which proved to be a carcinoma, a more common occurrence in general hospitals (Horn, 7). An explanatory synopsis of each of these two cases follows:

[1] Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5-10, 1948.

V. G., 58-year-old woman of Italian parentage, was admitted in 1942. She stated that for the past six months she had been conscious of a rapidly growing lump in her neck. Because she had previously been treated at the Institute for carcinoma of the uterine cervix, and to maintain contact and continuity of follow-up, she was scheduled for operation. The pathologist identified an unquestionably malignant core within the removed adenoma.

B. V., a woman 40 years of age, of Jewish ancestry, was admitted in 1942. She stated that her neck had been over-large since childhood but in the last six months a rapidly growing mass had appeared on the left side. During this period of rapid growth she had lost twenty pounds in weight. The preoperative diagnosis was "toxic nodular goiter, carcinoma to be ruled out." Upon histologic examination a portion of this adenoma was found to be malignant.

Both these women have been followed to date without evidence of local recurrence or distant metastasis.

In the twelve years of the Institute's existence, 40 patients have been admitted whose record fully substantiates a diagnosis of carcinoma of the thyroid gland. In each case the diagnosis was confirmed microscopically by Dr. Herman Bolker, pathologist for the Institute. In seven instances microscopic confirmation was established only on tissue obtained by needle biopsy of the thyroid tumor or a surgically removed metastatic lesion. Additional cases, in which a thyroid mass was known to be associated with bone or pulmonary metastases, were discarded for lack of cytologic proof.

As would be expected, by far the greater number of patients—33, or 83 per cent—were women. The remaining 7 were men. No children are recorded. The age range was from twenty-six to seventy-three years, with a mean average of 55+ as follows:

2d decade	1 patient
3d decade	4 patients
4th decade	12 patients
5th decade	7 patients
6th decade	12 patients
7th decade	4 patients
TOTAL	40

Twenty-one, or 52 per cent, of the group were of Jewish ancestry, all but 2 of whom had stemmed from Russia. But one Negro is included in the series, and this in spite of the large colored population of Brooklyn.

The histories indicated the presence of a mass in the neck for less than one year in 14 instances and for more than one year in 22 instances. In 4 cases the only symptoms were referable to metastases and no neck mass was recorded. These figures may be inaccurate both because of lack of observation on the patient's part and because of possible shortcomings in history taking. It is probable that in a far larger percentage of cases a neck tumor was present for a year or more, but unobserved. The following case illustrates how such a mass may be overlooked:

L. S., white female, was admitted to a neighboring hospital for removal of a kidney stone. On routine physical examination the resident physician discovered a thyroid tumor which up to that moment had not been observed by the patient. On section this proved to be a carcinoma of the papillary type. Following thyroidectomy the patient was referred to this clinic for radiation therapy.

A carcinomatous nidus within an adenoma may constitute but a small fraction of the entire growth. The fact that in the usual busy pathological laboratory it is only feasible to remove small portions of the total specimen for microscopic analysis has led to serious mistakes and to the misnomer, "benign metastasizing adenoma." Graham (8), by pointing out the characteristic tendency of the malignant adenoma to invade veins, and Simpson (9), by his brilliant exposé of the fallacy that a benign tumor will metastasize, have done much to dispel the veil of mystery which had been built up around thyroid tumors. Dr. Bolker, in classifying malignant tumors of the thyroid, has included the large-cell and small-cell carcinoma, as well as the so-called carcinoma-sarcoma, in the single group, anaplastic carcinoma. He agrees that all adenocarcinomata may contain papillary foci and, conversely, that most papillary carcinomata have segments in which gland arrangements may be seen. He has, therefore, classified the tumors

in accordance with the predominant element, papillary or adenomatous. Members of the Staff of the Brooklyn Cancer Institute have found the following classification both concise and sufficient:

1. Medullary or anaplastic carcinoma
2. Papillary adenocarcinoma
3. Adenocarcinoma
   (*a*) Adenocarcinoma of the Hürthle-cell type.
4. Squamous-cell carcinoma
5. Sarcoma

In analyzing this series a sixth subdivision is added to include those cases in which, because of scant tissue (needle biopsy) or because biopsy was limited to a metastasis, the pathologist was unable to distinguish the type of carcinoma and reported merely "carcinoma (apparently thyroid in origin)." The following tabulation represents our experiences in all cases in this series:

	Living	Dead	Total
1. Medullary or anaplastic carcinoma	3	6	9
2. Papillary adenocarcinoma	2	3	5
3. Adenocarcinoma	11	10*	21
(*a*) Hürthle-cell adenocarcinoma	1	0	1
4. Squamous-cell carcinoma	0	1	1
5. Sarcoma	0	0	0
6. Carcinoma (unclassified)	0	3	3

* One patient left the state and was lost to follow-up at the end of four years. All other cases have been followed to death or into 1948.

The clinical course of those suffering with carcinoma of the thyroid gland varies considerably. Certain thyroid carcinomata, particularly the adenomatous type, are notorious for their slow growth. These very tumors, however, tend to metastasize early, often before the parent neoplasm is recognizable. The colonizing cells, transported by the blood, tend to lodge and grow in bone or lung. True to the characteristics of the parent tumor, these metastases also grow extremely slowly. As a consequence, many patients live with their neoplasm for years, carrying on their normal to subnormal activities (Fig. 4). Cough, dyspnea, and dysphagia, due to

Fig. 1. Carcinoma of the thyroid, with mediastinal obstruction. Infra-red photograph.

encroachment of the tumor on the trachea and esophagus, or fractures secondary to metastatic growth in bone, eventually mark the beginning of the end (Fig. 1).

Since each subgroup tends to follow a more or less distinctive clinical pattern and to respond to therapy in a characteristic manner, the various types will be discussed separately, with illustrative cases.

1. MEDULLARY OR ANAPLASTIC CARCINOMA

(9 Cases)

Cytologically anaplastic thyroid carcinoma (Fig. 2) is a markedly dedifferentiated tumor. The supporting matrix is minimal. The acinous structure of the gland is replaced by sheets of cells without architectural design. Individual cell variations are pronounced; mitoses are numerous. In fact, the cells are apt to be so atypical that cases have been classified as carcinoma-sarcoma or as sarcoma. Without gland formation no colloid can be expected.

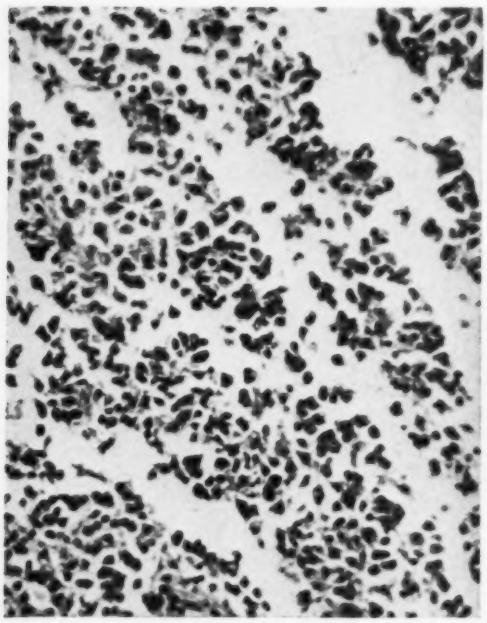


Fig. 2. Anaplastic carcinoma of the thyroid.

These tumors grow rapidly and metastasize early, usually not to bone. As with highly anaplastic tumors arising in other parts of the body, they may be radiosensitive but are not radiocurative. Of the 9 patients included in this subgroup, 3 are living. The fulminating character of the neoplastic spread is shown by the fact that 3 died within six weeks to eighteen months following discovery of a lump in the thyroid. In all, including the survivors, metastases developed, the following sites being listed: skin, lymph nodes, mediastinum, pleura, lung, and brain.

The following case history is typical of our experience with this group:

M. H., 62-year-old white female of Irish parentage, was admitted to the Brooklyn Cancer Institute in June 1940. She stated that within the last six weeks a mass had appeared on the right side of her neck and had grown rapidly. Over the past two days she had been able to swallow only small sips of liquid. The examiner described the thyroid gland as enlarged and fixed. A tracheal stridor was present. X-ray therapy gave partial relief from distressing tracheal and esophageal pressure symptoms. At operation, some six weeks after admission, the tumor was seen to consist of "a grumous, friable, hemorrhagic mass" without delimitation. A small specimen was removed and the incision closed. The pathologist reported this tissue as "anaplastic carcinoma of the thyroid gland."

The patient was discharged as improved in August 1940, only to be readmitted the following month. In this interval a left-sided pleural effusion had developed and numerous nodules had app ared in the skin below the operation scar (Fig. 3). Radium needles were inserted in an attempt to con-

Fig. 3. Anaplastic carcinoma of the thyroid (patient M. H.). Healed collar incision with tumor extension in suprasternal notch and multiple skin metastases below the scar.

trol this intradermal spread. In spite of her obviously poor condition the patient was again discharged in October 1940. She died at home early in January 1941. Her illness from onset to death spanned but little over six months.

One survivor in this small group was more recently referred to the Cancer Clinic (January 1948) following thyroidectomy elsewhere. She had known of a so-called goiter for the past eight years. A physician had previously advised her to "leave the goitrous nodule alone, if it does not bother!" At operation the neoplasm was seen to have spread deep into the mediastinum, and its total removal was not possible. The mediastinal residuum appears

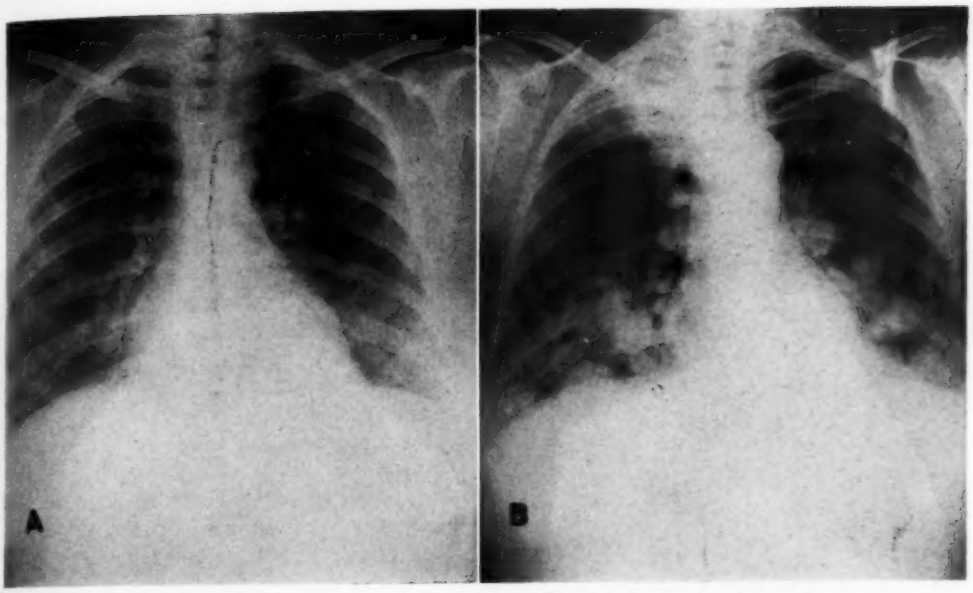


Fig. 4. Anaplastic carcinoma of the thyroid (patient R. S.). A. Chest film, April 1940, showing numerous pea-sized metastases. B. Chest film, October 1947, showing slow growth of pulmonary metastases in seven and a half years. See also Fig. 4C.

to have been held in check by x-ray crossfire. Radioactive iodine therapy was given and is justified on the theory that it will destroy any remaining functioning thyroid tissue, possibly metamorphosing the neoplastic cells into taking over some thyroid function. In this way the carcinoma cells may absorb a proportion of any further isotope medication.

Another survivor in this group has followed an unexpectedly protracted clinical course. Because of this exceptional chronicity her case is summarized:

R. S., 40-year-old white female, had noticed a swelling in her neck fully ten years previous to her admission to the Cancer Institute. In 1937 she applied to a neighboring hospital for admission. Their record states that a large nodular goiter was removed at that time. Analysis of what was supposedly a benign adenoma disclosed "medullary carcinoma." In 1940, some three years following thyroidectomy, the patient was admitted to the Brooklyn Cancer Institute complaining of a recurrent mass in the neck. This was seen to encroach upon and displace the trachea. In June 1942, a second thyroidectomy was performed at the Institute to relieve the pressure on the trachea, in spite of known lung involvement. Irradiation has since been given to the neck and to both lung fields.

Fig. 4. C. Patient R. S. (see Figs. 4A and B), in apparent good health in spite of pulmonary metastases of seven years duration.

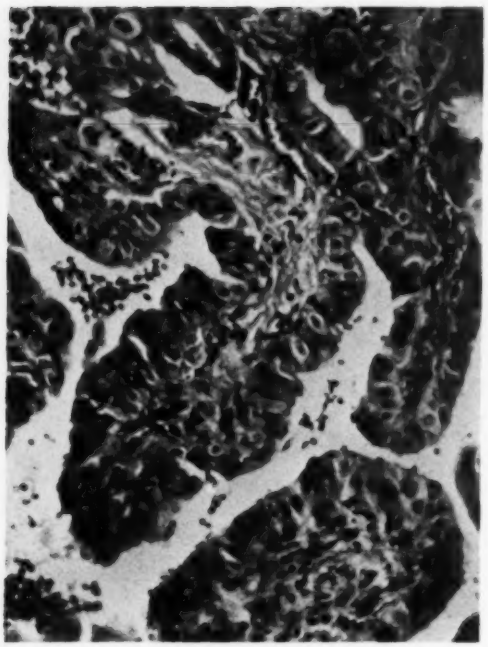


Fig. 5. Papillary adenocarcinoma of the thyroid. Note presence of glands at the base of several papillae.

The pulmonary metastases, asymptomatic till recently, have grown slowly but steadily over a seven-year interval (Fig. 4). In November 1947 and 1948 further effort was made to retard the growth of these now large pulmonary metastases by therapeutic doses of radioactive iodine. Tests as to the location of the radioactive isotope by Geiger counter were confused due to the large accumulation of the radioactive element within the nearby thyroid gland. Only a negligible percentage of the radioactive iodine was estimated to have been taken up by the pulmonary lesions. To date the patient remains in sufficiently good health to carry on her own housework, an interval of over eleven years having elapsed since she first became aware of a growth in her neck.

2. PAPILLARY ADENOCARCINOMA

(5 Cases)

Pemberton (10) states that this tumor has a predilection for invading lymph spaces to spread by way of cervical lymphatic chains. The size of the metastatic tumor frequently overshadows and masks the primary tumor so that at operation the original lesion may be overlooked. Rarely do distant metastases occur. Pemberton likens this papillary thyroid tumor to the papillary adenocarcinoma of the ovary. Just as a woman may live for many years in "good general health" after removal of the primary ovarian tumor, even though extensive intraperitoneal implants are present, so the patient with papillary adenocarcinoma of the thyroid gland with extensive cervical node metastases may live along quite comfortably until the growth exerts pressure on the trachea or esophagus. Both Pemberton and Lahey (11) mention the extreme radiosensitivity of this particular tumor, and this has been our experience at the Institute.

Microscopically this tumor is composed of papillae supported by a rich vascular stroma (Fig. 5). Vascular invasion is common. Colloid is scant or absent.

Of the 5 patients in this subgroup, 2 are living, having been followed two and ten years. The 3 who have died were admitted after extensive recurrence of their lesion, years after the original operative procedure. The following case history is illustrative of the survivors:

L. B., 37-year-old white male of Norwegian background, was first seen in December 1946, originally a patient of Dr. N. Brodie. Earlier that year an enlarged cervical lymph node had been removed at another hospital. The pathologist reported this as papillary adenocarcinoma of thyroid origin. The patient was referred back to the hospital and thyroidectomy performed, at which time the original focus within the thyroid gland was identified. X-ray therapy was carried out, the portals being so planned as to include the cervical chains on both sides of the neck. In February 1947 a lytic metastasis was identified in the neck of the second rib on the left (unusual for this type of thyroid carcinoma). This was given x-ray therapy but the patient did not experience relief of pain until the administration of radioactive iodine (first dose in April 1947, second dose in August 1947). This lytic rib segment has been shown to have partially regenerated. At present the patient is actively employed as a carpenter; there is no palpable recurrence in the neck and no other bone metastases have been discovered.

The other survivor, a woman of 44 years, first seen after thyroidectomy, has been followed for ten years after irradiation of the neck. To date there has been no palpable recurrence.

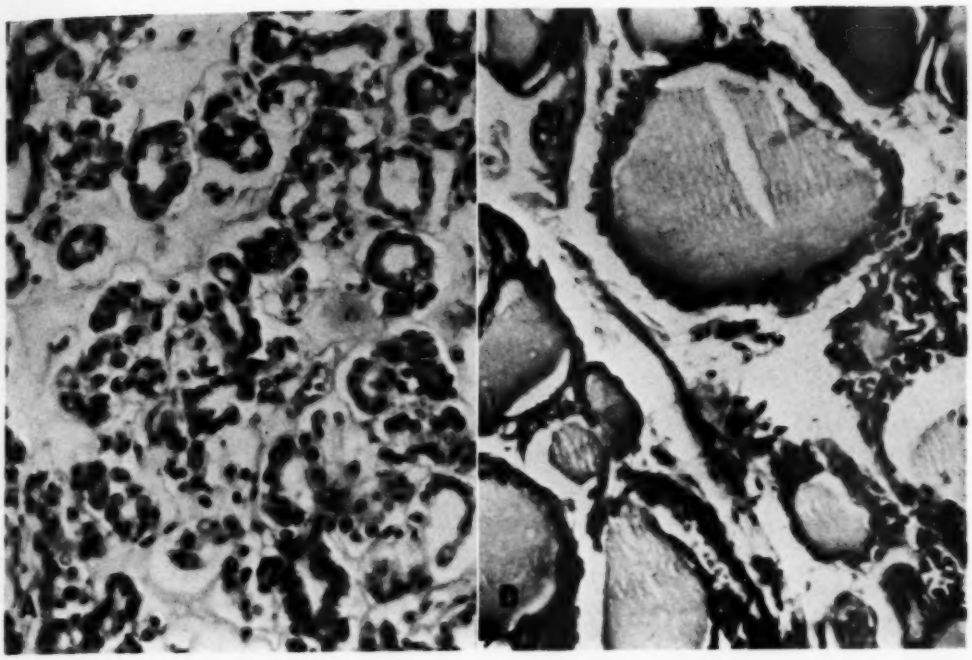


Fig. 6. A. Adenocarcinoma of the thyroid gland. The small glands suggest that this may have arisen in a fetal adenoma. B. Adenocarcinoma of the thyroid gland, of the type so often designated "benign metastasizing tumor of the thyroid."

3. ADENOCARCINOMA

(21 Cases)

All grades of transition from an original adenoma are included in this group (Fig. 6A–C) except pure papillary and pure scirrhous carcinoma. The amount of colloid present will vary markedly. The more mature type of tumor grows slowly and almost universally metastasizes by way of the blood stream (Graham, 12). Twelve of the 21 adenocarcinomas in our series are known to have metastasized; they are recorded as having spread to bone, lung, mediastinum, lymph nodes, peritoneum, adrenal glands, central nervous system, and buccal mucosa. The 11 survivors in this group have been followed on an average of five years, while the 10 patients who have died (including one lost to follow-up after four years) had been followed on an average of less than two years. X-ray therapy, by reducing the size of the neoplasm, has at times resulted

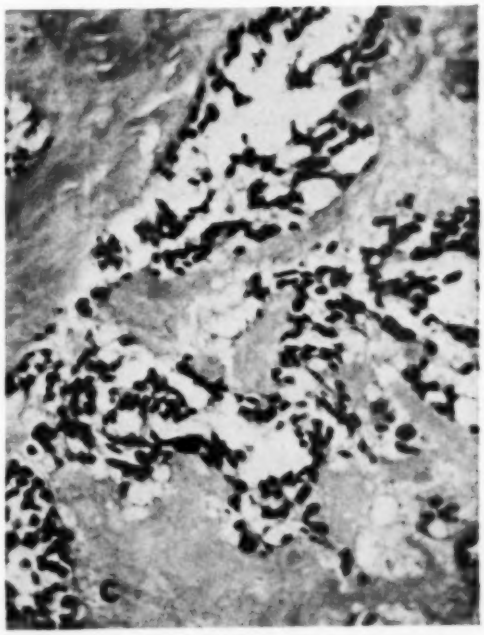


Fig. 6. C. Adenocarcinoma of the thyroid gland with fibrosis (slow growing). This appearance could follow intensive irradiation.

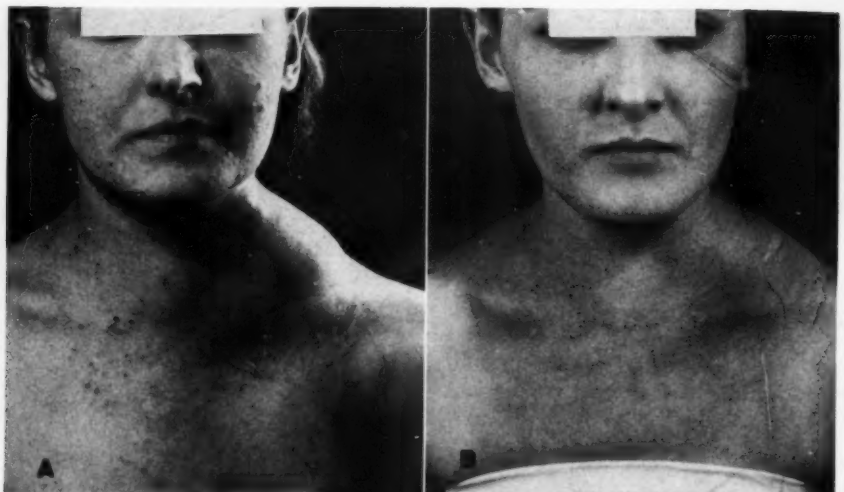


Fig. 7. Adenocarcinoma of the thyroid. A. May 9, 1938, prior to x-ray therapy. B. Nov. 7, 1938, following x-ray therapy. The pale scar marks the site of a biopsy incision.

in relief of pressure on trachea and esophagus to render an almost dramatic change in the patient's condition (Fig. 7).

The two case reports which follow illustrate the rather atypical, slowly progressive course so often observed in those suffering from adenocarcinoma of the thyroid, as well as the favorable response to radiation therapy.

L. F., 48-year-old Jewish female, was admitted to a nearby hospital in December 1935, complaining of a dry, hacking cough, made worse on lying down. According to her statement, she had had a goiter which had remained relatively unchanged as to size throughout the preceding fourteen years. The surgeon was able to resect only incompletely a large nodular thyroid mass weighing 88 gm., which obviously had infiltrated into surrounding muscle and trachea. The pathologist described the microscopic structure as resembling a fetal adenoma, with an orderly uniformity of architecture throughout. However, he wrote in part, "the capsule is destroyed in several places, with malignant cells in adjacent tissue. These cells have scattered mitotic figures and mild anaplastic character. The diagnosis is carcinoma of the thyroid, malignant adenoma."

Two and a half years later (February 1938) the patient sought admission to the Brooklyn Cancer Institute because of regrowth of the mass in her neck, which by this time was again partially occluding the trachea. The examiner described her as obese, orthopneic, and cyanotic. A walnut-sized, smooth, firm but freely mobile tumor mass presented into the suprasternal fossa. Another firmer, larger mass was felt beneath the sternomastoid muscle on the left. The trachea was visualized roentgenographically as narrowed and displaced to the right. The lungs were studded with innumerable "half-pea-sized" consolidations. Furthermore, the pedicle of the fifth dorsal vertebra was obliterated; the head of the left twelfth rib was destroyed, and a fingernail-sized lytic focus was present in the crest of the right ilium.

Instituted as an emergency procedure, x-ray therapy apparently shrank the tumor sufficiently to reduce the cyanosis and permit the patient to breathe with less difficulty. About this time a papilloma, which appeared to arise just beneath the left vocal cord, was snared off. This papilloma was reported as "aberrant thyroid tissue (carcinoma?)." The patient was discharged three months after admission as improved. She died at home fully a year later.

This woman had harbored a thyroid tumor (benign or malignant?) for fourteen years before submitting to thyroidectomy. The surgeon succeeded in removing a large thyroid mass but observed that the tumor had invaded nearby muscle and trachea. Following this incomplete surgical removal, the patient carried on for two years more before she again sought relief from stridor due to a partial tracheal constric-

tion. Her respiratory embarrassment was relieved by radiation and intratracheal polypectomy. In all, she survived some eighteen years after she first became aware of the existence of a tumor in her neck.

S. H., 50-year-old housewife of Scandinavian antecedents, was transferred from a nearby hospital to the Brooklyn Cancer Institute in September 1939. The pathologist of the referring institution had reported on tissue taken from the posterior surface of the right sacroiliac joint as "thyroid carcinoma." For a year and a half preceding this biopsy the patient had complained of pain originating in the joint and referred down the right leg. In this interval she had lost 35 pounds in weight. A thyroidectomy had been performed at this same referring hospital ten years before. During the intervening decade there had been no recurrence of tumor in the neck.

The pathologist's report from the referring institution is quoted in part: "The tissue consists of a closely packed mass of small acini resembling those of a fetal adenoma of the thyroid.... The acini vary somewhat in size but all are small. Their lumina are filled with pale pink colloid.... No mitotic figures are seen and anaplasia is very slight."

"Sections of the original tumor from the thyroid removed ten years ago were reviewed. The appearance of these is essentially similar to the present biopsy. Histologically both are indistinguishable from a benign adenoma...!"

Examination at the Brooklyn Cancer Institute disclosed a mediastinal extension on the left, as well as metastasis to the fifth lumbar vertebra. X-ray therapy resulted in marked relief of pain and the patient was discharged as "improved." On readmission six months later (March 1940), the body of the fourth cervical vertebra had collapsed, a pathological fracture had occurred in the right femur, and pulmonary as well as other bone metastases were present.

Death occurred in November 1941, over two years after the first admission to the Brooklyn Cancer Institute, twelve years after thyroidectomy, and three and a half years after onset of symptoms due to bone metastasis.

3a. HÜRTHLE-CELL ADENOCARCINOMA

(1 Case)

These tumors maintain their glandular structure (Fig. 8) and they may therefore be considered as a subdivision of adenocarcinoma. The Hürthle cells which line the acini are large cells with foamy cytoplasm. Eosinophilic granulations are to be found in their cytoplasm. Like the adenocarcinoma, this is a slow growing neoplasm, as is illustrated by the single case listed at the Brooklyn Cancer Institute:

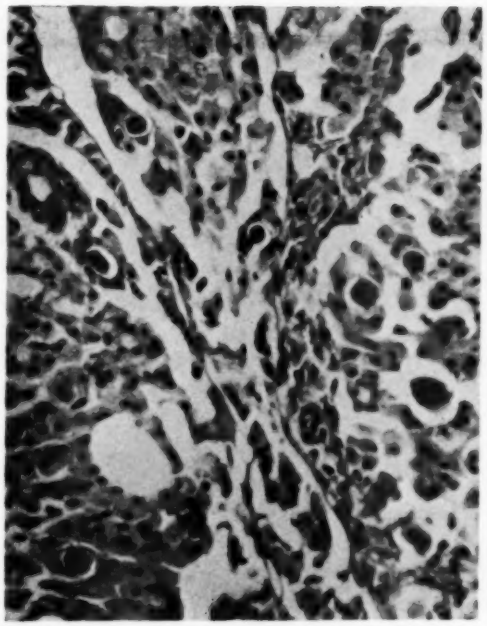


Fig. 8. Adenocarcinoma of the thyroid gland, Hürthle-cell type.

A. S., 41-year-old Jewish woman, was referred to the Brooklyn Cancer Institute for x-ray therapy following removal (April 1945) of what was supposed to be a thyroid adenoma. On section, this proved to be an adenocarcinoma of the Hürthle-cell type. Treatments were completed in May 1945, the estimated tumor dose being 5,000 r. In the three years which have elapsed since the completion of this radiation therapy no local recurrence or metastatic developments have as yet been uncovered.

4. SQUAMOUS-CELL CARCINOMA

(1 Case)

Squamous-cell carcinoma (Fig. 9) of the thyroid is extremely rare. Its origin is frequently ascribed to extension from the nearby esophageal or tracheal mucosa or remnants of a thyroglossal duct. Broders (13), however, considers that this tumor may arise directly from the thyroid gland by metaplasia of its epithelium. But a single case is listed in our series:

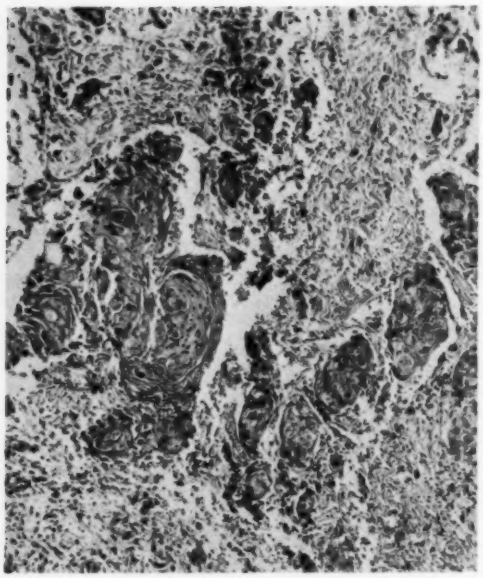


Fig. 9. Squamous-cell carcinoma of the thyroid gland.

M. L., white female, age 69, complaining of a mass in her right neck, was admitted to the Brooklyn Cancer Institute in October 1937. This tumor had grown rapidly in the preceding six months, during which time there had been a 20-pound weight loss. The patient had also experienced occasional shooting pains radiating down her right arm. On physical examination a Horner's syndrome was observed. An immobile mass, the size of a fist, filled the right supraclavicular fossa and extended up beneath the sternomastoid muscle, occupying most of the anterior triangle of the neck. The superficial veins were dilated over the neck and upper thorax. An ascitic fluid wave could be obtained over the abdomen. X-rays confirmed the presence of a mass in the right shoulder-neck angle. The lower half of the right lung field was atelectatic and the right diaphragm was immobile. There was a complicating bronchial pneumonia. Death occurred within one month of admission (November 1937).

The anatomicopathological diagnosis taken from the autopsy protocol follows: "Squamous cell carcinoma of thyroid origin with extension to: (*a*) lymph nodes and soft tissues of neck, (*b*) brachial plexus, (*c*) mediastinal lymph nodes, and (*d*) superior vena cava: secondary extension to myocardium, left pulmonary artery, liver."

5. SARCOMA

Even though it is admitted that thyroid glandular epithelium is supported by a connective-tissue stroma which theoretically could be the focus of a sarcomatous new growth, Ewing (14) states: "...the occurrence of true sarcoma [of the thyroid] in man still requires demonstration." Lymphosarcoma frequently involves the deep cervical lymph nodes adjacent to the thyroid gland. That in any specific instance lymphosarcoma arises in the thyroid gland proper and not in adjacent lymphatic structures would indeed be most difficult to prove. For this reason, no lymphosarcoma has been included in this series even though the thyroid was grossly involved. In writing of the giant-cell tumors which frequently present many of the criteria of sarcomatous mesoblastic origin, Broders (13) concludes that all of these tumors are actually highly anaplastic carcinomas and not sarcomas (Fig. 10). In a review of 40,000 thyroid specimens at the Mayo Clinic, sarcoma was reported in but 4 instances (Pemberton, 10). The following two case reports clearly indicate pitfalls involved in prematurely considering

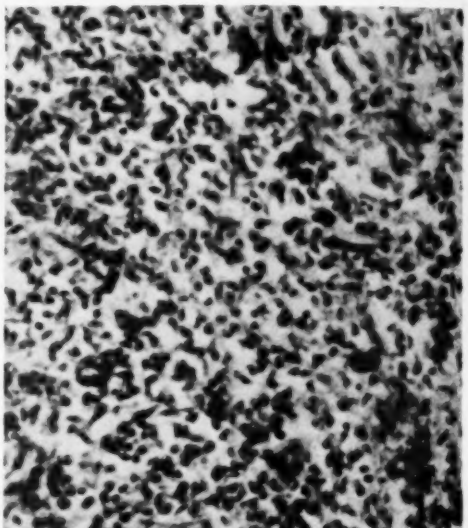


Fig. 10. Anaplastic carcinoma of the thyroid gland of sarcoma-like appearance.

Fig. 11. Adenocarcinoma of the thyroid gland. A. Residual carcinoma and recent operative scar. B. Following irradiation. Note residual tumor on the left.

lesions of the thyroid gland as sarcoma and explains why no sarcoma is listed in our series:

J. H., 70-year-old Jewish male, had had a rapidly growing neck tumor removed in another hospital three months before admission to the Cancer Institute (February 1942). At operation the growth was seen to extend deep into the superior mediastinum. The pathological diagnosis was: "(1) sarcoma involving thyroid, (2) multiple adenoma of thyroid, and (3) struma lymphomatosa." A tracheotomy had to be performed at the Brooklyn Cancer Institute before a cycle of x-ray treatments could be completed. The patient was discharged the latter part of March as improved but was readmitted two months later because of bleeding from the tracheotomy tract. At this time, further x-ray therapy was delivered into the superior mediastinum, the tumor dose being 5,000 r. No improvement resulted and the patient died a few days following his last scheduled treatment. At autopsy the pathologist noted: "On opening the thoracic cage, this large mass extended from the neck, involving all the structures of the anterior superior mediastinum." Only after careful analysis of the autopsy material, including microscopy, as well as evaluation of the location of metastases (mediastinum, retroperitoneum, pancreas, and kidney) was the final diagnosis changed to anaplastic carcinoma.

Z. S., 64-year-old Jewish female of Spanish extraction, stated that she had always enjoyed good health up to the time of a thyroidectomy some twenty-four years previously. Fourteen years later the so-called goitrous tumor recurred and she submitted to a second operation. Just a year before admission a third operation was done. Tissue removed at the second operation was reported as lipoma and colloid goiter; that removed at the third operation, as myxosarcoma. In addition the patient had received a series of x-ray treatments at another New York hospital. On admission to the Brooklyn Cancer Institute a mass the size of a fist was palpated in the right lateral lobe of the thyroid gland. A substernal mass was also shown to be present by x-ray. The patient was dyspneic and slightly cyanotic.

A tracheotomy had to be performed a few days after admission. A tracheo-esophageal fistula, however, caused food to be regurgitated through the tracheotomy opening as well as to be inhaled into the lung. Death occurred within ten days.

On careful review of the record, which appeared to furnish rather insufficient evidence to prove that the myxosarcoma arose within the thyroid gland proper and not from adjacent mediastinal structures, the case just described was eliminated from this series.

UNCLASSIFIED CARCINOMA

(3 Cases)

In each of the three cases of unclassified carcinoma the disease was advanced when the patient was first seen at the Institute.

Surgery was limited to needle biopsy or biopsy of a superficial lymph node metastasis, done only to substantiate the clinical diagnosis. The size or complexion of the specimen in each instance was only sufficient to warrant the diagnosis of "carcinoma." The presence of thyroid tumor and the nature of the metastatic spread were considered sufficient to confirm the microscopist's impression as to the primary site. Not one of these patients lived eight months, the average survival being but four months. Radiation therapy gave but slight palliation, due probably to the extent rather than the pathological type of neoplasm.

METASTASES

An apparent long latent period exists during which many of these thyroid neoplasms grow slowly and, even though they may have metastasized widely, present few if any symptoms. Patients are wont to tolerate the neoplasm well, showing little evidence of intoxication or deterioration. The four autopsies in this series confirm the ability of a thyroid neoplasm to spread widely through the body. The accompanying diagram presents the sites of metastatic spread obtained from an analysis of the clinical records of the entire group, as well as the autopsy findings.

SURGERY

According to Haagensen (15), Braun in 1885 collected 34 cases in which surgical extirpation had been done for malignant disease of the thyroid. The operative mortality was 64 per cent and 22 per cent of the survivors died of recurrence within one year. At present the operative mortality has been slashed to a negligible figure, but there is little change in the prognosis when the lesion can be clinically diagnosed preceding surgery. The exceptions to this rule are to be found in specific instances in which the disease is unilateral and a radical hemithyroidectomy can be carried out along with complete neck dissection on the affected side.

As previously stated, a high percentage

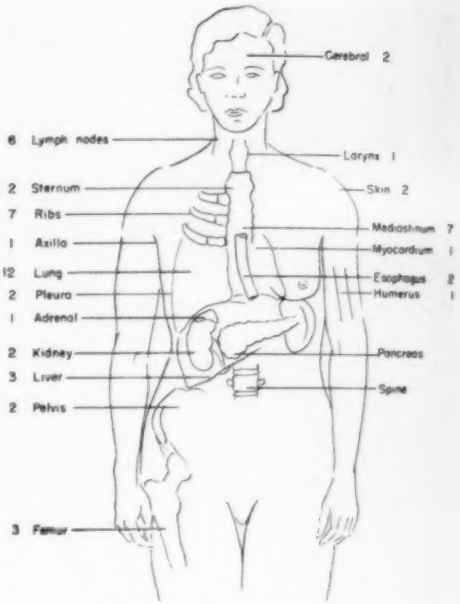


Diagram showing sites of metastasis

of the cases reviewed here (22 of 40) had had thyroidectomy preceding admission. Five thyroidectomies were performed at the Institute. Two cases were explored, but, because of the extent of the process, only a small section was removed for biopsy. Three patients who survive today without evidence of local or distant spread are those whose preoperative diagnosis was "thyroid adenoma."

IRRADIATION

X-ray Therapy: Twenty-six patients (two-thirds of those included in this report) received x-ray therapy. The usual technic calls for two anterior ports, one to the right and the other to the left of the midline; the size of the ports varies from 6×8 to 8×15 cm. The central ray is so directed that the exit beam emerges posteriorly on the opposite side of the neck. When possible, a central lead strip is used to shield the larynx and trachea. From 100 to 200 r in air is delivered daily to each of the two portals until a tumor dose of from 3,000 to 5,000 r has been accumulated. The factors used are 200 kv., filtration 0.5

Fig. 12. Anaplastic carcinoma (patient V. V.). A. Bleeding mass fungating from recent operative scar, June 10, 1948. B. End-result following radium and x-ray therapy, Aug. 11, 1948.

mm. Cu plus 1.0 mm. Al, h.v.l. 0.8 mm. Cu, target-skin distance 50 cm. Such intensive therapy frequently diminishes the size of the tumor and on occasion has given relief from tracheal or esophageal pressure symptoms. As stated in consideration of the pathological groups, the papillary carcinomata and adenocarcinomata responded most favorably to radiation (Fig. 11). Lymph node, pulmonary, and bone metastases were observed to be uniformly more resistant to equivalent doses of radiation than the parent tumor.

Radium: Haagensen (15) reports favorable experience with the insertion of radon seeds into the remaining tumor at thyroidectomy. This appears to be a logical procedure but has not been carried out to date at the Brooklyn Cancer Institute. Radium needles were inserted into a recurrent fungating carcinoma once and into intradermal metastatic lesions twice. The estimated tumor dose delivered in these instances was up to 5,000 gamma r. The response to this interstitial radiation was minimal except in the following instance.

V. V., 64-year-old male, Italian by birth, had had a subtotal thyroidectomy because of a rapidly growing thyroid tumor. Postoperatively the scar broke down, with a fleshy, rapidly growing mass protruding through the gaping wound. The tumor was covered with a bloody ooze which continued to trickle off its surface. Two efforts to excise this tissue and close the wound were unsuccessful. The patient was transferred to the Brooklyn Cancer Institute in an exsanguinated condition in June 1948. Tissue removed at operation was reported as anaplastic carcinoma. At the Institute radium tubes were dropped into the sinus tract for a total of 4,800 mg. hr. in two weeks. To this a tumor dose of 2,400 r was added by x-ray. Within a month the sinus tract had healed. With cessation of blood loss the hemoglobin rose to normal. To date there is no evidence of further extension of the carcinoma (Fig. 12).

Radioactive Iodine: A tremendous amount of investigation is being carried out with radioactive iodine. The selective absorption of iodine by thyroid tissue would theoretically make this modality ideal for treatment of thyroid cancer. Unfortunately it is only the rare thyroid neoplasm which retains the functional characteristics of the parent organ. Six pa-

Fig. 13. Slow growth of bone metastases from thyroid carcinoma. A. Dec. 29, 1944. B. April 1, 1948. More recently the metastatic process has been held in check by radioactive iodine.

tients in this series were treated with I^{131} in single or multiple doses. In each instance the isotope was shown to be absorbed within the residual thyroid gland in large amounts, at least on the original dose. The thyroid gland usually swelled perceptibly within twenty-four hours, and there was associated tenderness, particularly on pressure. As a rule, the patient also complained of a sore throat and difficulty in swallowing. These symptoms appeared to be at their height three days after therapy and thereafter subsided rapidly, to disappear within one week. Proof that measurable amounts of I^{131} were absorbed within metastases was obtained but twice, and in these instances only following the original dose. In both these cases pain due to bone metastases, which was most distressing, was relieved within a few hours and the patients have remained pain-free to date. In one instance x-ray studies indicate partial bone regeneration; in the other there has been no evidence of regeneration but the process has ceased to extend (Fig. 13).

Appearance of thyroid deficiency has followed a therapeutic dose of 70 to 85 millicuries. Transient symptoms suggestive of a mild thymic tetany appeared as a latent complication in two instances. This so-called thymic tetany consisted of muscular twitchings, stiffness of fingers, and inability to write legibly with pen or pencil. This impresson of thymic injury was never confirmed by appreciable change in serum calcium, phosphorus, or phosphatase levels. Traces of albumin were found in the urine of one patient though his blood chemistry was normal.

SUMMARY

Factors entering into the causation and incidence of carcinoma of the thyroid gland are discussed.

Forty proved cases of thyroid carcinoma admitted to the Brooklyn Cancer Institute in the past decade are analyzed. Pathologically these cases are classified as anaplastic carcinoma; papillary adenocarcinoma; adenocarcinoma (including Hürthle-cell adenocarcinoma); squamous-

cell carcinoma; unclassified carcinoma. There were no cases of sarcoma in this series.

Adenocarcinoma apparently arising in adenoma forms by far the largest group in this series, with 50 per cent of the patients surviving five years or longer. Only 6 other survivors are listed in the entire series. The high percentage of survival among patients suffering from adenocarcinoma is ascribed to the response of this neoplastic entity to radiation therapy, to the slow growth of the original tumor and its metastases, and to the exceptional tolerance of these patients for their neoplasm.

Surgery is successful in eliminating small localized carcinomata within adenomata and in removing large thyroid masses, with relief of pressure on the adjacent trachea and esophagus. Surgery in combination with radiation appears to have improved the life expectancy in the more advanced cases.

Radioactive iodine (I^{131}) has resulted in symptomatic relief in at least two instances. This experience would appear to justify its further use in suitable cases.

152 Clinton St.
Brooklyn 2, N. Y.

BIBLIOGRAPHY

1. PORTMANN, U. V.: Malignant Diseases of the Thyroid Gland. Am. J. Roentgenol. **32:** 508–515, October 1934.

2. WEGELIN, C.: Malignant Disease of the Thyroid Cland and Its Relations to Goiter in Man and Animals. In Studies on Diagnosis and Nature of Cancer. Baltimore, Wm. Wood and Co., 1930.

3. COLE, W. H., SLAUGHTER, D. P., AND ROSSITER, L. J.: Potential Dangers of Nontoxic and Nodular Goiter. J. A. M. A. **127:** 883–888, April 7, 1945.

4. STOUT, A. P.: Tumor Seminar (Case 15). Texas State J. Med. **40:** 366–391, November 1944.

5. MASON, J. T.: Exophthalmic Goiter in the Pacific Northwest. Surg., Gynec. & Obst. **42:** 663–666, May, 1926.

6. Department of Health, City of New York. Personal Communication signed by Louis Weiner, Chief Statistical Division, Nov. 19, 1947.

7. HORN, R. C., JR., WELTY, R. F., BROOKS, FRANK P., RHOADS, J. E., AND PENDERGRASS, E. P.: Carcinoma of the Thyroid. Ann. Surg. **126:** 140–155, August 1947.

8. GRAHAM, A.: Malignant Epithelial Tumors of the Thyroid with Special Reference to Invasion of the Blood Vessels. Surg., Gynec. & Obst. **39:** 781–790, December 1924.

9. SIMPSON, W. M.: Three Cases of Thyroid Metastasis to Bone, with a Discussion as to the Existence of the So-Called "Benign Metastasizing Goiter." Surg., Gynec. & Obst. **42:** 489–507, April 1926.

10. PEMBERTON, J. DEJ.: Treatment of Carcinoma of Thyroid Gland. Ann. Surg. **100:** 906–923, November 1934.

11. LAHEY, F. H.: Discussion following paper by Pemberton (10).

12. GRAHAM, A.: Maligant Tumors of the Thyroid. Ann. Surg. **82:** 30–44, July 1925.

13. BRODERS, A. C., AND PEMBERTON, J. DEJ.: Primary Osteogenic Sarcoma of the Thyroid Gland. Report of a Case. Surg., Gynec. & Obst. **58:** 100–102, January 1934.

14. EWING, J.: Neoplastic Diseases. Philadelphia, W. B. Saunders Co., 4th ed., 1940, p. 992.

15. HAAGENSEN, C. D.: Cancer of the Thyroid: Its Radiosensitivity. Am. J. Cancer **15:** 2063–2105, July 1931.

DISCUSSION

Robertson Ward, M.D. (San Francisco): Drs. Howes and Foote have presented a most interesting group of cases of malignant goiter and an intriguing theory of their origin. Whether or not carcinoma of the thyroid gland arises in the minute foci of hyperplasia described by them is still an unsolved question. However, there is little doubt that carcinoma of the thyroid is much more common in areas of endemic goiter and, as Dunhill has indicated, the gland, handicapped by iodine deficiency, may well be over-stimulated to the point of carcinogenesis by its efforts to produce a normal amount of secretion.

In regard to incidence, stage of advancement, and prognosis, it should be remembered that statistics from a cancer institute are weighted from the outset, as the only cases seen in such an institution are already diagnosed or strongly suspected as malignant before being referred for treatment. I feel sure that my own statistics are somewhat influenced by my expressed interest in the subject, entailing a higher percentage of suspected cases of cancer than would be seen in the general run of the mill. The authors emphasize this when they state that a large number of their patients are admitted with advanced disease.

I feel that there is a very valuable lesson to be learned from the two cases in which thyroidectomy was performed for a supposed benign adenoma. First, both patients are living and apparently free of recurrence six years after treatment, a very different outcome than in those diagnosed or suspected to be malignant before operation. Second, though it is not stated, you can be confident that neither of these patients had a simple enucleation of the adenoma. Thus, the authors have reported upon all the factors influencing prognosis except early recognition. These factors are: the stage of advancement as shown by diagnosability, prospect of complete removal of the tumor, the pathological classification as to anaplasia, and finally the sensitivity of the tumor to radiation. A few years ago my statistics showed that patients dead of the disease or living

with recurrence numbered 80 per cent of those in whom cancer was diagnosable before operation, 40 per cent of those in whom diagnosis was made at operation, and 20 per cent of those whose lesion was first proved malignant in the laboratory.

Early recognition and prophylaxis is the most important factor in prognosis when cancer of the thyroid is considered as a disease entity. There is little the radiologist can do in this field except to diagnose distant metastases and treat recognized cases. He can, however, profit by our statistical studies, in knowing under what circumstances carcinoma is liable to develop, and in spreading this knowledge to his non-radiological colleagues. Therefore I would like to call your attention to the groups in which most thyroid cancers will be found. They are (1) solitary nontoxic nodules; (2) nodular goiters in males; (3) nodular goiters in children.

The prognosis as related to pathological classification of the tumors in this series, as in most others, can be pretty well summarized by stating that it is best when the tumor is purely of the papillary type and becomes progressively worse as the pattern departs from the papillary, through the alveolar pattern, into the completely undifferentiated, anaplastic, and entirely patternless types. The reasons why the papillary tumors are less malignant are two. First, they tend to spread by the lymphatics rather than by blood vessel invasion; second, they are more sensitive, and remain sensitive longer, to radiation. My experience with the anaplastic, unclassified, and pseudo-sarcomatous tumors has been even more hopeless than the authors'. None have responded even slightly to radiation, and all are dead within six months of discovery or operation.

I would like to leave with you the following primer of "don'ts" designed to save patients with this disease:

1. Don't wait for signs of cancer. There are none pathognomonic of early malignancy.
2. Don't forget the ever-present threat of *nodular goiter.*
3. Don't forget that your patient may be the one in twenty with an *unsuspected* cancer.
4. Don't fail to recommend operation in children and men with nodular goiter.
5. Don't neglect to advise surgical removal (not enucleation) of solitary tumors of the thyroid.
6. Don't be guilty of telling your patient "That lump in your neck is harmless; wait till it bothers you."
7. Don't be pessimistic about carcinoma of the thyroid if you have followed the above advice; four out of five of your patients will have a good prognosis.

SUMARIO

Carcinoma Tiroideo

Analízanse 40 casos comprobados de carcinoma del tiroides. La clasificación se conformó a la siguiente división: (1) carcinoma anaplásico; (2) adenocarcinoma papilar; (3) adenocarcinoma (incluso carcinoma de las células Hürthle); (4) carcinoma escamocelular; (5) sarcoma; y (6) carcinoma inclasificado. No hubo casos de sarcoma en la serie.

El adenocarcinoma aparentemente originado en adenoma formaba con mucho el grupo mayor (21 casos) y reveló el coeficiente más alto (50 por ciento) de sobrevivencias de cinco años. Sólo hubo 6 sobrevivencias más en toda la serie. El elevado porcentaje de sobrevivencias largas en el adenocarcinoma es imputado a la respuesta del tumor a la irradiación, al lento desarrollo de la neoplasia primaria y de sus metástasis y a la excepcional tolerancia de fos enfermos al tumor.

La cirugía resulta efectiva para eliminar los pequeños carcinomas localizados en adenomas y para extirpar grandes tumefacciones tiroideas, aliviando así la presión ejercida sobre los adyacentes esófago y tráquea. La cirugía combinada con la radiación parece haber mejorado la expectativa de vida en los casos más avanzados. Los carcinomas y adenocarcinomas papilares respondieron muy favorablemente a la irradiación (rayos X).

El empleo del radio fué limitado. En un caso una masa sangrante que proyectaba de la cicatriz de una tiroidectomía antigua fué tratada con éxito con el radio y los rayos X. En este caso el diagnóstico fué carcinoma anaplásico.

El yodo radioactivo logró mejoría sintomática por lo menos en dos casos, y su empleo parece justificado en casos apropiados.

Graves' Disease

Twenty-five-Year Follow-up of Cases Receiving Roentgen Therapy[1]

J. MARION READ, M.D.

San Francisco, Calif.

THE PURPOSE OF this paper is to report the present status of 15 patients who received roentgen irradiation for Graves' disease twenty-five years ago. This follow-up study was undertaken at the suggestion of confreres who have been using radioactive iodine in the treatment of this disease with satisfactory immediate results. They reasoned that, since the histologic appearance of thyroid tissue after roentgen irradiation and the administration of radioactive iodine is practically identical (1, 2), a survey of these twenty-five-year cases might give an idea of the late clinical results to be expected from their treatment.

The small series reported here constitutes part of a larger group of about one hundred thyrotoxic patients who came under observation between 1920 and 1926. This study, which is solely a clinical one, has therefore been extended over a quarter of a century, its continuing pursuit being motivated by the author's interest in this strange malady and his convictions concerning its etiology and treatment.

The major stimulus to this work at its inception was the conviction, first, that the natural course of this disease was inclined to be long, and, second, that thyroidectomy was not the final therapeutic answer. No long-term research was planned, but youthful enthusiasm and continued hammering at the above thesis led to the gradual accumulation of the records of patients treated non-surgically. Since 1924, eight reports (3) upon various phases of this work have been published. From the nature of its beginning, therefore, it will be understood that no program was established at the outset and consequently the cases may be considered as unselected, since all types of thyrotoxic patients were studied and treated. That is not entirely true in the 15 cases reported here, since all of these patients had typical Graves' disease, which will be defined later. None had previously undergone thyroidectomy, and all received roentgen-ray therapy at some time during the course of the illness. Also, these 15 cases constitute a group which was reported upon in 1931, under the title "Thyrotoxicosis—End Results in Its Roentgen Treatment." In the opening paragraph of that report is this sentence: "The impression seems to be widespread among those who favor surgical removal that irradiation of the thyroid is only palliative and seldom results in permanent cure." I attempted to show at that time that these 15 patients, at least, had remained well for a period of three to eleven years. However, it has been said that the medical history of a thyrotoxic patient ends only at his death. Granting that contention, this subsequent follow-up, after twenty to twenty-eight years, may be considered final, because some of the group are dead, while others have attained, and some have exceeded, their normal life expectancy at the time they were first seen.

Before discussing briefly the three criteria used for inclusion in this series, I wish to define Graves' disease. It is a constitutional disease of unknown etiology, usually with insidious onset, marked by nervousness, and a tendency to run a long course with remissions and exacerbations which are occasionally marked by crises. There is always increased heat production with accompanying tachycardia, sweating, and weight loss. In the later stages there

[1] Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

TABLE I: STATUS OF PATIENTS WITH GRAVES' DISEASE, TWENTY-FIVE YEARS AFTER ROENTGEN THERAPY

No.	Name	When First Seen			Status in 1932	Status in 1948			
		Age	Ordinary Life Expectancy to Year	B.M.R.		Age	Years of Life Expectancy Remaining	B.M.R.	Remarks
1	Mrs. E. B.	34	1954	+23%	Cured	60	6	...	Patient's physician reports her cured
2*	Mrs. M. D.	45	1947	+112%	Cured	71	0	− 2%	Health fair. Telangiectases of neck
3	Mrs. H. C.	41	1950	+67%	Cured	67	2	+ 3%	General health good, despite blood pressure of 214/108
4	Mrs. C.	60	1936	+60%	Cured	..	Exceeded 9 yrs.	...	Died 1945 at 83 yr. 10 mo. (reported cause, acute pulmonary edema). Blood pressure in 1932 160/100
5	Mrs. R. B.	32	1956	+42%	Cured	56	8	...	Patient's physician reports her cured; has fast pulse rate
6*	Mrs. B. M.	28	1959	+42%	Cured	53	11	−27%	Slight anemia. B.M.R.: 1931, −1%; 1938, −6%; 1941, −13%
7	Mrs. B. S.	48	1945	+45%	Cured	73	Exceeded 3 yrs.	− 1%	General health good. Mild diabetes
8†	Mrs. J. G.	45	1946	+45%	Cured	71	Exceeded 2 yrs.	...	Patient's physician reports her cured
9†	Mr. K. S.	37	1955	+66%	Cured	60	7	+ 8%	Very well. Passed life-insurance examination in 1941
10	Mrs. V. F.	43	1954	+54%	Chronic	63	6	...	Thyroidectomy in 1934. Less nervous. No weight gain
11	Mrs. G. B.	49	1947	+55%	Chronic	72	0	− 4%	Hyperventilation. Cardiac decompensation
12	Miss E. R.	12	1974	+40%	Cured	35	26	...	Reports by letter that she has remained well; no relapse
13	Mr. R. S.	43	1951	+65%	Chronic	66	3	...	Could not be located for follow-up report in 1948
14	Miss C. H.	42	1952	+62%	Cured	..	...	...	Died in another city; cause unknown
15	Mrs. F. S.	27	1946	+23%	Chronic	..	...	...	Died in 1946. Alcoholic; suicide

* Case history reported in detail in Endocrinology **8:** 746, 1924.
† Case history reported in detail in California & West. Med. **37:** 25, 1932.

is uniform thyroid enlargement (hyperplasia) and often exophthalmos, with or without the other eye signs due to increased muscle tonus. There are usually muscle tremor and weakness; often insomnia and pigmentation. In the more extreme cases there are vomiting, diarrhea, and mental aberration.

By this definition, toxic nodular goiter is excluded on the basis of type of thyroid enlargement alone. It is also differentiated upon other grounds, as age of onset, course, and often the previous existence of goiter. This is not the place to discuss whether or not so-called toxic adenoma should be included under the heading of Graves' disease. Certainly the former has some features which distinguish it as probably a disease primarily of the thyroid, and thyroidectomy seems the procedure of choice, with a lower mortality rate and more certainty of cure than can be expected in Graves' disease. I do not wish to imply that roentgen irradiation should be reserved exclusively for the patient with Graves' disease, because I know from experience that irradiation can be very beneficial in nodular toxic goiter. I often resort to it if thyroidectomy is contraindicated because of cardiac or other complications.

The reason for including only cases of Graves' disease in this series is to ascertain if the results of roentgen therapy equal or surpass those of thyroidectomy, since irradiation has the definite advantage of lower morbidity (and consequently lower cost) as a result of the procedure itself, and also it should have no mortality *per se*. The claims of surgeons as to the effectiveness of subtotal thyroidectomy are so well known that no comparative study will be made here. Only the results from non-surgical treatment, including roentgen irradiation, will be presented, so that anyone who wishes may study and make comparisons.

It should be stressed here that roentgen therapy, as well as surgical treatment, is directed at the thyroid. The thymus, of course, is also irradiated and sometimes the pituitary (the adrenals only rarely), thus recognizing the disturbed function of the whole endocrine system in this strange disease. On the other hand, in surgical therapy only the thyroid gland is dealt with. The object of both surgical and roentgen therapy is the destruction or ablation, of thyroid tissue, and in this respect they differ only in method and degree. They can yield satisfactory results only in so far as the thyroid participates in the syndrome we know as Graves' disease, and in proportion to the amount of thyroid tissue destroyed. To those who subscribe to the theory that Graves' disease is primarily a disease of the thyroid, partial or subtotal destruction of the gland seems a satisfactory therapeutic procedure. The fact that such procedures too often afford unsatisfactory results casts much doubt upon the validity of this theory. All therapy to date has been empiric, and no one of the hundreds of methods employed has resulted in a cure rate anywhere approaching 100 per cent. There can be no rational therapy of this disease until its etiology is discovered and its pathologic physiology thoroughly understood.

The foregoing should make plain why only patients with Graves' disease who had not previously undergone thyroidectomy are included in this series. I am aware that recrudescences after thyroidectomy have often been successfully treated by the roentgen rays (1), and more recently by radioactive iodine (2). This fact should increase the popularity of irradiation as a therapeutic measure, but in no way alters the position of those of us who believe that the thyroid is only secondarily involved in the disease process. It should serve to remind us that the disease, with its long course marked by exacerbations and remissions, is one in which the *post hoc ergo propter hoc* fallacy is apt to lead to erroneous deductions as to the effect of therapy.

In considering the results of roentgen irradiation in these 15 cases, it should be understood that each patient had, also, other appropriate non-surgical treatment. After 1923 most of them received iodine.

A few were hospitalized, but only one (Case 2, Table I) for longer than a week or two at a time. As roentgenologists, you might hope that I could report a series receiving only irradiation therapy, but as an internist I would consider that as "subtotal therapy," and some of these patients were so ill as to require all the therapeutic aid at our command, short of surgery. The occasional patient in whom thyroidectomy was considered was deemed too ill to survive the operation, and the surgeon seemed relieved when irradiation was suggested.

This prompts me to add that the cases in this series were unselected in another sense than those already mentioned, namely, as to severity. The only objective measure we had was the basal metabolic rate, which, however, is not a completely satisfactory criterion. The initial rates in this series ranged from plus 23 per cent to plus 112 per cent, with an average of 53.4 per cent, which is higher than in most reported series treated by irradiation. To satisfy doubts as to the severity in the case of the patient with a basal metabolic rate of 112 per cent, her detailed history may be scrutinized in a previous report (3*b*).

The irradiation, in all cases except one, was directed by the late John M. Rehfisch. With only slight variations the following technic was employed: weekly exposures of 200 r over each lobe, the rays generated at 130 kv. and filtered through 0.25 mm. of copper and 1.0 mm. of aluminum. Twelve such treatments constituted a full course, and only a few of the more severe cases received more than one course in a year. In several obstinate cases another, but shorter, course was given in the second year. The treatment in each case is detailed in the report of 1932 (3*g*). In 3 cases receiving only four, five, and six treatments each, the exact dosage could not be determined from the records when the first follow-up study of this series was made. The remaining 12 patients received from three to twenty-one exposures, with dosages ranging from 600 to 6,090 r, this largest being given to the patient with the initial basal metabolic rate of plus 112 per cent. This lady, and one or two other patients, suffered some telangiectases and thinning of the skin over the treated areas. No instance of skin cancer has developed in this series.

The remaining pertinent data are presented in Table I, where the present status of all but one of the original 15 patients reported in 1932 is recorded. Five were seen and re-examined personally; 2 reported from a distance by letter, and I received reports from the personal physicians of 3 others. The only one who has since had a thyroidectomy I talked with by telephone. Three are known to be dead.

In addition to recording each patient's present health status (under "Remarks," Table I) and the metabolic rate in the 6 cases for which it was obtained, I also have calculated the life expectancies. Five exceeded the normal expectancy of life calculated on their ages when first seen, and on life expectancy tables of 1920, which expectancies in the fifth to seventh decades do not differ much from those of the 1940 tables. One of these 5 died at the age of almost eighty-four.

Eleven patients were reported as cured in 1932 and the 9 who are still living have remained well. One died in a distant city of unknown cause, but I was told that death was not due to her former thyrotoxicosis. The other was the patient who lived into her eighty-fourth year.

Four cases were reported as chronic sixteen years ago. One patient in this group has undergone thyroidectomy, one died a suicide, one I was unable to locate, and the other is living at seventy-one, having exceeded her normal expectancy. She is a hyperventilator, and also, of recent years, has suffered from congestive heart failure.

In none of the 14 patients traced has malignant exophthalmos developed, nor did the exophthalmos existing at the time of treatment fail to recede and the eyes return to normal.

SUMMARY

Fifteen cases were resurveyed twenty-five years after non-surgical treatment, in-

cluding roentgen irradiation, for Graves' disease. Of 14 who could be traced, 9 are living and well at ages ranging from thirty-four to seventy-three years; 3 are dead from other causes; one has undergone thyroidectomy with only fair results; one is living at seventy-one years with disease which must be classed as chronic. Five exceeded the normal life expectancy.

These cases were unselected as to severity, the initial basal metabolic rates ranging from plus 23 per cent to plus 112 per cent, with an average of 53.4 per cent.

No ill effects of roentgen treatment were observed except in one case requiring several courses of treatment, with resultant skin atrophy and telangiectases over the area irradiated. Only one patient may be regarded now as having hypothyroidism. She lives in an endemic goiter area and her metabolic rate has gradually fallen to minus 27 per cent, without signs of myxedema.

CONCLUSIONS

Roentgen irradiation serves as a helpful adjunct in the non-surgical management of Graves' disease by suppressing the function of, and even destroying, thyroid tissue. In so far as the thyroid participates in the pathologic physiology of this disease, irradiation will accomplish the same result as surgery. There is no mortality *per se*, as the treatment is unattended by any of the objectionable features, hazards, and postoperative complications and sequelae of thyroidectomy.

The long-term results of roentgen irradiation are as satisfactory as those of surgery in terms of ultimate cure and attainment of life expectancy. This will also probably prove true of irradiation with radioactive isotopes of iodine, whose action is so similar clinically and which produce the same histologic changes in the thyroid gland.

490 Post St.
San Francisco, Calif.

REFERENCES

1. SOLEY, M. H., AND STONE, R. S.: Roentgen Ray Treatment of Hyperthyroidism. Arch. Int. Med. **70:** 1002–1016, December 1942.

2. CHAPMAN, E. M., AND EVANS, R. D.: Treatment of Hyperthyroidism with Radioactive Iodine. J. A. M. A. **131:** 86–91, May 11, 1946.

3. READ, J. M.: (*a*) Roentgen-Ray Therapy in Thyrotoxicosis: Its Effect as Measured by Basal Metabolic Rate. California State J. Med. **22:** 10–15, January 1924.

(*b*) Use of Iodine in Exophthalmic Goiter. Endocrinology **8:** 746–756, November 1924.

(*c*) Management of Exophthalmic Goiter. J. A. M. A. **83:** 1963–1968, Dec. 20, 1924.

(*d*) Prognosis in Exophthalmic Goiter. Am. J. M. Sc. **171:** 227–239, February 1926.

(*e*) Graves' Disease: Probable Reasons for Failure to Discover Its Etiology. J. A. M. A. **88:** 1697–1699, May 28, 1927.

(*f*) Treatment of Cardiac Disturbances Due to Thyroid Disease. J. A. M. A. **89:** 493–496, Aug. 13, 1927.

(*g*) Thyrotoxicosis—End Results in Its Roentgen Treatment. California & West. Med. **37:** 25–30, July 1932.

(*h*) Cardiac Status After Prolonged Thyrotoxicosis. Am. Heart J. **8:** 84–90, October 1932.

DISCUSSION

Edwin C. Ernst, M.D. (St. Louis, Mo.): It has been most refreshing to many of us older radiologists to have presented a twenty-five-years experience in the treatment of abnormal thyroid conditions by an internist. Not only is this review a most careful evaluation of clinical results, but, in retrospect, it is of special interest, since it recalls the early days when many of us participated in controversial discussions regarding the relative values of surgical, medical, x-ray, and radium therapy in Graves' disease.

First of all, we should give consideration to the fact that life expectancy in the middle-aged group—after twenty-five years—is limited even under normal thyroid conditions. Another significant point is that in the series reported the basal metabolic rate averaged 54 plus, ranging from 23 to 112 plus. Today, with earlier diagnosis and improved medical management, we see fewer of these more severe exophthalmic cases.

Many years ago, when the Southern Medical Association met in New Orleans, the surgical and radiological sections arranged for a combined scientific program, the subject for discussion being exophthalmic goiter. A leading surgeon opened the program by showing eight lantern slides illustrating skin injuries over the thyroid gland due to radiation and thereafter discussed only the advantages of surgery in Graves' disease, with the result that the metabolic rate of the radiologists present rose rapidly.

Today we have been presented with a most comprehensive and conservative evaluation by a clinician in co-operation with the radiologists. The total x-ray dose given in most of these cases is much less than we employ today. The proof of the pudding is in the eating when we analyze the good results obtained at the termination of twenty-five years.

We agree with the author that each dose should be individualized and administered conservatively. If one could study the charts shown on the screen, it would become self-evident that the majority of the cases treated were of the advanced toxic type.

The complications accompanying Graves' disease have not been discussed to any great extent, but there are many. In these cases we depend upon the referring physicians for advice and medical management after and during the roentgen treatment. The good results obtained are due to the excellent clinical management and careful follow-up received by these cases.

Since the introduction of radioisotopes, more particularly radioiodine, we are entering a new zone of therapy, and in the future this form of radiation must be given serious consideration.

I wish to express my appreciation for the privilege of discussing and commenting upon this evaluation of the twenty-five-year end-results in the roentgen treatment of Graves' disease.

W. Edward Chamberlain, M.D. (Philadelphia, Penna.): No one was more interested in this paper than I, for from 1920 to 1930 Dr. Read and I worked elbow to elbow. I hope that you will not misunderstand me when I say that it may be that with the treatment we gave in those days all we were really doing was to keep the patient from surgery. After all, thyroid toxicosis runs a course. Dr. Read taught me that back in 1920, and I bring the matter up at this time not to cast any doubt on his results. These are fine. I wish every doctor would follow his cases for twenty-five years or longer. But when we come to a result such as this, I am reminded of the changes that have taken place. Now we have radioactive iodine, and now we know better than ever before just how large a dose of radiation is required to produce an immediate reduction in the function of thyroid tissue. This dose we find is much larger than we ever gave in the old days. Add to these observations the fact that we have been using very large doses for cancer of the larynx without seeing any destruction of thyroid tissue or of thyroid function, and we have three things which make me raise this question: Were we not perhaps, back in the earlier days when these cases were treated, merely keeping the patient from surgery and giving the disease a chance to go on to recovery, as thyroid disease may without removal of the thyroid?

I hope this doesn't sound silly. I know Dr. Read, and I know he is giving us the exact facts, but I can't help wondering, for, after all, we used a mighty small amount of x-rays in those cases. What do you say, Dr. Read?

Dr. Read (*closing*): There are two points that I wish to make. First, I have contended for many years, as Dr. Chamberlain can testify, that Graves' disease runs a rather definite and characteristic course. It is true that in treating these patients with roentgen rays we give the disease time to run its natural course, which is to recovery in the majority of cases. However, I am certain that irradiation does effect a change in thyroid tissue, actually destroying it and therefore accomplishing the same end as surgery—and without any mortality. This effect has been shown repeatedly in pathological studies of treated thyroids.

The second point I wish to make is regarding so-called toxic adenomata. I believe that here we should proceed differently, since we have a condition which, while it has yielded to irradiation therapy, nevertheless is better treated by ablation of the gland. The reasons are too numerous to go into at this time, but unless there is some contraindication the toxic nodular goiter should be treated surgically.

SUMARIO

Enfermedad de Graves. Veinticinco Años de Observación de Casos que Recibieron la Roentgenoterapia

Este repaso abarca 15 casos de enfermedad de Graves (sin comprender bocio nodular tóxico), tratados hace veinticinco años. Todos los enfermos recibieron la roentgenoterapia aparte de otra terapéutica no quirúrgica apropiada. Ninguno había sido objeto de una tiroidectomía antes. Los casos variaban en gravedad, oscilando las tasas del metabolismo basal entre + 23 por ciento y + 112 por ciento.

De 14 enfermos cuyo paradero pudo descubrirse, 9 se hallan vivos y sanos a una edad de treinta y cuatro a setenta y tres años; 3 han muerto de otras causas; 1 experimentó una tiroidectomía con resultado puramente mediano; y 1 se halla vivo a la edad de setenta y un años con una enfermedad crónica. Cinco enfermos han superado su expectativa normal de vida. No se observaron efectos contraproducentes de la irradiación aparte de atrofia y telangiectasias cutáneas en un enfermo que necesitó

varias series de tratamiento. Un solo enfermo, que vive en una zona de bocio endémico, puede considerarse que tiene hoy día hipotiroidismo.

La roentgenoterapia sirve, pues, como útil coadyuvante en el tratamiento no quirúrgico de la enfermedad de Graves, por suprimir la función del tejido tiroideo, y hasta destruirlo. Hasta donde el tiroides participa en la fisiopatología del mal, la irradiación logrará el mismo resultado que la cirugía. No hay mortalidad *per se*, y el tratamiento no va acompañado de las características adversas, riesgos y complicaciones y secuelas de la tiroidectomía.

Los resultados a largo plazo de la roentgenoterapia son tan satisfactorios como los de la cirugía en términos de curación finally consecución de la expectativa de vida. Esto rezará probablemente también con la irradiación con isotopos radioactivos del yodo, cuyo efecto es tan semejante clínicamente y que producen las mismas alteraciones histológicas en el tiroides.

Roentgen Therapy of Carcinoma of the Skin of the Eyelids[1]

J. A. del REGATO, M.D.
Colorado Springs, Colo.

CARCINOMAS OF the skin of the eyelids are frequently diagnosed in a relatively early stage; they may become serious therapeutic problems, however, depending upon the character and the adequacy of the treatment that is first instituted. Carefully planned curie therapy or a surgical excision and subsequent plastic repair are capable of controlling these tumors; but, while no greater certainty of control of the lesion is offered, the functional and esthetic results of such hazardous or elaborate procedures are far from comparable with those which are obtained by the judicious application of roentgen therapy.

INCIDENCE

In the first six years of work, 1,343 consecutive basal-cell carcinomas, 439 epidermoid carcinomas, and 2 adenocarcinomas of the skin of the face, which had received no previous treatment, were observed in the Ellis Fischel State Cancer Hospital; 12 per cent of the basal-cell carcinomas and 1 per cent of the epidermoid carcinomas arose from the skin of the orbit. This report is based on 168 consecutive cases of carcinoma of the skin of the eyelids, and of the inner and outer canthi, in patients who were admitted from May 1940 to December 1945, who have now been followed for a minimum of three years; this series includes 21 patients with a recurrence following previous inadequate treatment.

A proportion of one female for every three males is found in our series of carcinomas of the skin of the face. In the group of carcinomas of the skin of the orbit the proportion of females is slightly higher. Our 168 lesions were observed in 163 patients, of whom 108 were men and 55 women.

Our youngest patient was thirty-five years old, and the oldest eighty-nine years; the average age was sixty-seven years and the median age seventy years. It may be significant that women were in the majority among the younger patients; 19 of the 35 patients under sixty years of age were females (Table I).

TABLE I: AGE DISTRIBUTION OF PATIENTS WITH CARCINOMA OF THE SKIN OF THE ORBIT, ACCORDING TO SEX
(Note the greater proportion of females among the younger patients)

Age→	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	TOTAL
Males	0	0	5	4	7	14	20	16	23	9	10	108
Females	2	2	3	4	8	4	4	14	9	2	3	55
TOTAL	2	2	8	8	15	18	24	30	32	11	13	163

CLINICAL ASPECTS

Most carcinomas of the skin of the orbit arise from the middle or lateral third of the lower eyelid near its ciliary border; next in frequency are the carcinomas of the inner canthus developing around or under the lacrimal caruncle: 80 per cent of the carcinomas of this series arose from the lower eyelid or inner canthus (Table II). The growth usually presents well defined limits with no visible ulceration or a small central loss of substance (Fig. 3); less frequently the carcinoma arises from a preexisting area of dyskeratosis and there may be an ill-defined superficial ulceration. Even the advanced lesions seem to stop at the ciliary border and do not infiltrate the

[1] From the Department of Radiotherapy, the Ellis Fischel State Cancer Hospital, Columbia, Mo. Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

palpebral conjunctiva. We have observed a few lesions, however, in which the carcinoma presented no bulk but involved the entire ciliary border of the lower lid, producing a long and narrow ulceration and shortening the height of the lid at the expense of both the cutaneous and conjunctival aspects.

Like other basal-cell carcinomas of the skin, those arising in the orbit present a relatively slow development; patients seek aid somewhat earlier for these tumors than they do for similar ones arising elsewhere, due to the natural fear associated with lesions neighboring the eye and because of their conspicuousness. Epidermoid carcinomas develop rapidly and may be widely ulcerated when first seen. We have studied a few relatively early epidermoid carcinomas of the upper eyelid that showed bulk but as yet no ulceration of the skin. This has led us to believe that the very few epidermoid carcinomas that actually arise in this region may more likely originate from the palpebral conjunctiva (Fig. 1). We seldom see an advanced lesion of the eyelids that has received no treatment; most advanced lesions that we see, and therapeutic problems that we face, are the product of the casualness with which treatment has been previously administered.

Fig. 1. Epidermoid carcinoma of the upper eyelid. Note the bulk of growth and little visible ulceration. The tumor arose in all probability from the palpebral conjunctiva.

TABLE II: HISTOPATHOLOGY AND APPARENT SITE OF ORIGIN OF 168 CARCINOMAS OF THE SKIN OF THE ORBIT

	Lower Eyelid	Inner Canthus	Outer Canthus	Upper Eyelid
Basal-cell carcinomas (total 159)	65	60	17	17
Basosquamous carcinomas (total 2)	0	1	1	0
Epidermoid carcinomas (total 7)	3	2	2	0
Total 168	68	63	20	17

DIAGNOSIS

The majority of carcinomas of the eyelids can be easily recognized clinically; a biopsy should of course be done in all cases for histopathologic confirmation. *Xanthelasma* is usually multiple and appears on the medial half of the upper as well as in the lower eyelid; these yellowish non-ulcerated concretions are characteristic. *Senile papillary lesions*, pigmented or not, are often pedunculated and never ulcerated, but they may offer a problem in diagnosis if they become infected, and biopsy may be sometimes necessary to differentiate a non-pedunculated papillary lesion from carcinoma. *Palpebral gland cysts* are easily recognized in that the tumefaction they produce is deeply situated while the overlying skin appears normal. Rare *mixed tumors* may be found in this area but they seldom involve the skin. *Lymphosarcomas* of the eyelids are relatively benign; they present as non-ulcerated, soft, diffuse tumefactions of the lid with a characteristically slow rate of growth (Fig. 2). Finally, *epidermoid carcinomas of the palpebral conjunctiva* may also present originally as diffuse tumefactions not apparently involving the skin. Later, however, they may become ulcerated outwardly and be taken for a primary carcinoma of the skin of the eyelid.

PATHOLOGY

It is a mystery in the etiology of carcinoma of the skin that basal-cell carci-

Fig. 2. Lymphoma of the orbit. The lesion had characteristic slow growth and radiosensitivity and presented no metastasis.

nomas predominate in certain areas (forehead, eyelids, nose, skin of the lips, chin), while in others epidermoid carcinomas are in greater than normal proportion (temple, ears, pre-auricular regions, dorsum of hands). Accepting the hypothesis that basal-cell carcinomas originate from the cells of the basal layer and pilosebaceous infundibula, and that epidermoids arise in more superficial layers of the epidermis, Lacassagne theorized that basal-cell carcinomas develop especially where the epidermis is thin and the ultraviolet rays have a better chance to reach the basal layers; the areas of the skin which have a thick epidermis would give rise predominantly to epidermoid carcinomas, for most of the solar rays are absorbed in the superficial layers. Magnusson failed to find anatomic confirmation of Lacassagne's views, but the theory is suggestive and requires a more adequate verification on a large number of elderly subjects.

In their development, basal-cell carcinomas may become adherent to the bone, particularly at the inner canthus, but do not involve it until much later; following unsuccessful treatment, the tumor may present deep, diffuse infiltration of all orbital structures, including the eye. Epidermoid carcinomas that arise from or involve this area show much greater ability to infiltrate neighboring structures.

The overwhelming majority of our carcinomas of the skin of the orbit were basal-cell carcinomas: only 7 of the 168 lesions were epidermoid carcinomas. Taking into consideration that three of these patients came to us with diffuse recurrences from previous treatment, that two others had extensive lesions that could have arisen in neighboring regions, and that one had a tiny epidermoid carcinoma *in situ*, it appears that an epidermoid carcinoma of the skin of the orbit is a great rarity if not a questionable entity. One of our patients presented an epidermoid carcinoma that involved the outer canthus and eventually metastasized to the pre-auricular lymph nodes; in another the inner half of the orbit was involved and metastases were present in the submaxillary and cervical lymph nodes. The spread of both these tumors is in agreement with our knowledge of the lymphatic drainage of the eyelids.

TREATMENT

The treatment of carcinomas of the skin of the orbit must attain the main purpose of controlling the tumor without directly or indirectly compromising the vision and with the best possible esthetic result. Obviously, any form of treatment that offered better functional and esthetic results at the expense of curability would not be justified, since the primary aim of the treatment of cancer is the control of the tumor. Cauterizations, narrow excisions, timid applications of radiotherapy may start with a genuine hope of sufficiency but usually prove deceitful and end in considerably greater impairment than would otherwise have been necessary; recurrences usually demand extensive irradiation, with subsequent cataracts, or enucleations and exenterations which could

Fig. 3. Basal-cell carcinoma of the lower eyelid.
Fig. 4. Same patient, well after five years. Roentgen therapy was administered in 19 days.

have been avoided if adequate treatment had been instituted in the first place (Table VI). Conversely, there is no justification for radical procedures that imply interference with function or disdainful disregard of esthetic impairment while offering no greater assurance of control of the tumor than less mutilating methods.

Surgery: Very rarely is a simple wide excision suitable for the treatment of carcinoma of the skin of the orbit. When the excision is capable of encompassing the entire growth, the closing and healing of the wound imply undesirable retractions, ectropion, chronic lacrimation, etc. Simple excision may be indicated in a few cases, however, when by virtue of advanced age, blindness, chronic disease, etc., the expeditiousness of the procedure is more important than the relative imperfection of the results. Much better results may be obtained by wide excision and autoplasty; this delicate procedure would be often justified were it not that its results are not always perfect and that they can be improved upon by well adapted roentgen therapy. More extensive surgical procedures, with enucleation of the eye or exenteration of the orbit, may be indicated in advanced cases; in recurrences from inadequate treatment the wide and intensive irradiation that is required may need to be complemented by surgical removal of the necrotic orbital contents.

Curie Therapy: The interstitial application of radium as a form of treatment of carcinomas of the eyelid has had its vogue (Laborde). The implantation of radium element needles offers an opportunity for intensive irradiation of a small well defined area, the dosage decreasing considerably a short distance from the source of radiations. It is difficult, however, to use this form of treatment in other than very limited lesions of the lid, and it is not equally successful when applied to large lesions or to those arising in the canthi. Moreover, since no eye shield can be used that effectively protects the lens from irradiation when radium is used (Hunt), a number of irradiation cataracts result; often interstitial curie therapy produces marked changes in the delicate structure of the lids, with consequent discomfort or dysfunction. Sixteen of the cases in this report were treated by interstitial irradiation with radium element needles; in most cases two needles of 5 mg. of radium in 1 cm. of length were inserted parallel to each other, about 1 cm. apart, and a dose of 200 mg. hr. was administered in twenty hours. While the procedure is expeditious and has

Fig. 5. Basal-cell carcinoma of the outer canthus.
Fig. 6. Same patient, well after four years. Roentgen therapy was administered in four weeks.

been unquestionably successful, it is certainly inferior to a protracted course of roentgen therapy.

Radium may also be used in surface application in a specially made mold (a miniature of the radium molds that have been used in the treatment of carcinoma of the lower lip), but this elaborate procedure requires great care and does not offer any advantage that cannot be improved upon by roentgen therapy. In the past six years we have used no radium in the treatment of carcinoma of the eyelid.

Roentgen Therapy: No form of treatment offers greater possibilities of control of carcinoma of the skin of the orbit than does roentgen therapy; and no other method possesses the suppleness of roentgen therapy that makes it adaptable to the circumstances of the case whether the tumor arises on the lid or on the canthus, and whether the lesion is large or small. We use 110 kv., with a target-skin distance of 15 cm., and prefer to filter through 0.25 mm. of copper; extensive recurrences are treated with 220 kv. and 1.0 mm. of copper. An eye shield is used in the majority of cases unless the lesion is very small and the beam can be directed away from the eye; in addition, a cut-out of lead is placed over the skin and fixed in place by the pressure of the tube-head piece. Rarely a patient may be very sensitive to the ophthalmic anesthetic used for the introduction of these shields and it may then be preferable to forego the anesthetic or, if possible, do without a shield; we have observed a case, not in this series, of blindness through keratitis following prolonged congestive reaction to the anesthetic. Eye protection may not be possible in some extensive lesions, particularly diffuse recurrences after a first unsuccessful treatment.

A short intensive treatment may be capable of controlling a carcinoma of the eyelid, but the value of roentgen therapy consists mainly in the possibility of protraction, which will reduce to a minimum the untoward effects. Treatments of only a few days duration may successfully control small lesions and result in negligible sequelae, particularly when the lesions are not close to the ciliary border; but as the field of irradiation increases in size, it is most satisfactory to protract the treatment. Most of our treatments were given in about three weeks and some extended to five or seven weeks in total duration. We feel that daily treatments are preferable.

Basal-cell carcinomas of the eyelids do not require a very large daily dose: 100 or 150 r repeated each day will easily sterilize

Fig. 7. Basal-cell carcinoma of the inner canthus recurring after treatment with zinc chloride paste. Note existing ectropion.

Fig. 8. Same patient, well after five years. He is satisfied with the result and refuses consideration of cosmetic surgery. Vision has been preserved. Roentgen therapy was administered in six weeks.

these tumors provided the total dose accumulated after weeks is sufficient in itself. Unless the tumor is very small, we seldom start with more than 150 r per day, but the daily dose is in general raised to 200 and later to 250 r, depending on the size of the lesion.

Although these lesions can be permanently controlled with the administration of a total dose of less than 2,000 r (calculated at the skin without back-scatter), under the circumstances outlined above, the proportion of recurrences is greater when such a low total dose is given. Our total delivered dose varies according to the size of the field and the protraction. For a field 1.5 to 2 cm. in diameter and a treatment lasting three to four weeks, we usually accumulate 4,000 to 5,000 r (calculated at the skin without back-scatter); a slightly smaller total dose is permissible with shorter treatments, but no less than 3,000 r should be given. With the use of very small fields, and consequently little added scatter radiation, a larger dose is necessary, all other conditions being equal; treatments lasting six weeks may require a total dose of 7,000 r unless the field is rather large, in which event a slightly smaller dose may be satisfactory.

A moist radio-epidermitis of the skin always results from these treatments; if the treatment is of long duration the skin reaction may appear before the end of the contemplated course. While the intensity of the daily dose administered, the size of the field, and the total dose, as well as the protraction, are most important factors in the production of permanent changes, the good care or neglect of the radio-epidermitis will be greatly responsible for the ultimate changes. A neglected skin reaction, one that does not receive daily attention until normal repair has occurred, will become infected and inflamed; as a consequence, not only will healing be retarded but there will result a greater amount of replacement fibrosis, achromia, avascularity, and a number of late necrotic accidents that can be avoided when the same reaction receives proper attention. The care of irradiation reaction is as much the duty of the radiotherapist as postoperative care is that of the surgeon. When the patient is incapable of procuring this attention in his own neighborhood, we prefer to keep him in the hospital until the skin is healed. We have these reactions carefully dressed at least twice a day by a capable nurse. Daily care con-

sists of spraying with a mild antiseptic as soon as the dermis becomes denuded and removal of fragments of dead epidermis and incrustations. The denuded area is kept constantly covered with a dressing of lanolin or vaseline gauze. Even with adequate care, thrusts of cellulitis may occur, but they are easily controlled by sulfonamides or antibiotics.

Control of a carcinoma of the eyelid usually implies permanent epilation of at least part of the cilia. This epilation, even when complete, does not in itself result in any dysfunction, particularly when the eyelashes of the opposite lid are long and sufficient in themselves to fulfill their common function (Fig. 6). Scarring from a lesion of the inner canthus may result in stenosis of the lacrimal canal and consequent chronic lacrimation.

RESULTS

Of 161 patients with basal-cell carcinomas in this material, 2 refused treatment, 9 were treated surgically, 16 received interstitial curie therapy, and 134 were treated by roentgen rays.

TABLE III: THREE-YEAR RESULTS OF SURGICAL TREATMENT OF BASAL-CELL CARCINOMAS OF THE ORBIT

(All lesions except one were under 1.5 cm. in diameter, but the choice of patients was unfavorable to the procedure)

Total cases treated	9
Simple excisions	5
Excisions and skin graft	3
Exenteration (for previously treated case)	1
Dead of intercurrent disease before 3 years	2
Living with cancer	2
Well 3 years or more	5

The results of surgical treatment are summarized in Table III. These are given in an effort to avoid segregation of material that may cloud the opportunity to appreciate the over-all results; but no comparison should be drawn with the results of other methods, for the choice of patients was unfavorable to surgery. In addition to the 5 cases controlled out of the 9 treated, surgery is to be credited with the control of one recurrence following curie therapy and 5 recurrences after roentgen therapy administerd in our hospital.

TABLE IV: FIVE-YEAR RESULTS OF INTERSTITIAL CURIE THERAPY OF BASAL-CELL CARCINOMAS OF THE EYELIDS

Cases treated	16
Recurrence (controlled by excision)	1
Irradiation cataract	2
Marked atrophy	3
Epidermization of the cornea	1
Died of intercurrent disease before 5 years	3
Lost to view before 5 years	1
Well 5 years or more	12

The results of interstitial curie therapy are shown in Table IV. There are 12 patients surviving five years or more in the small series of 16 cases, with only one recurrence; but 2 irradiation cataracts and 3 cases of marked atrophy resulted, while in another patient the epidermis grew over the conjunctiva and cornea following intense reaction.

The results of roentgen therapy of basal-cell carcinomas of the skin of the orbit not previously treated are detailed in Table V. There were 9 recurrences in this group of 117 cases; most of these occurred in small lesions that were treated with small fields (and consequent little back-scatter) and total doses at the lower limit of sufficiency (*i.e.*, 2,900 r in fourteen days, 4,000 r in thirty days). In a few aged uncooperative patients the inadequacy of the irradiation had been acknowledged during the course of treatments and the recurrence was expected. All recurrences were subsequently controlled.

It is important to emphasize that no case of cataract has developed in this series of 117 patients; in only one case there has been a slight diminution of vision noted. There were two cases of necrosis that subsequently healed: in both instances the treatment had been relatively short. Two patients have a chronic lacrimation apparently due to insufficiency of the lacrimal canal, but the difficulty has not been of such an intensity as to interfere with vision. Another patient has complained of pain in his eye and still another had an acute purulent infection of the eye, from which he recovered without sequelae. Other than these, there have been no com-

TABLE V: THREE-YEAR RESULTS OF ROENTGEN THERAPY OF BASAL-CELL CARCINOMAS OF THE SKIN OF THE ORBIT WHICH HAD RECEIVED NO PREVIOUS TREATMENT

(All of the recurrences were subsequently controlled so that no patient in this series actually died of cancer)

	Total Lesions Treated	Number of Recurrences	Dead of Intercurrent Diseases Before 3 Years	Lost to View Before 3 Years	Living and Well 3 Years or More Following Treatment	Absolute 3-Year Survival, %
Upper eyelid	8	0	1	0	7	..
Outer canthus	15*	1	3	0	12	..
Inner canthus	46*	3	4	0	42	91
Lower eyelid	48	5	7	1	40	83
Total	117	9†	15	1	101	86

* Including one basosquamous carcinoma.

† Four were subsequently controlled by roentgen therapy, four by excision, and one by curie therapy.

plications attributable to the treatment. Seventy-four patients of this group have been followed from five to eight and a half years. There were no additional recurrences after three years; 2 cases were not traced; 15 patients died of intercurrent diseases, and 57 remained well for five years or longer, a 77 per cent absolute five-year survival after roentgen therapy of basal-cell carcinomas that had received no previous treatment.

The results of roentgen therapy in 17 cases of recurrent basal-cell carcinomas following previous treatment (surgery, electrocoagulation, zinc chloride paste, radiotherapy) elsewhere are shown in Table VI. Another case of recurrent basal-cell carcinoma was treated surgically (Table III). The treatment of these patients required that much greater consideration be given to the attempt to control the tumor than to the resulting defect or impairment (Fig. 8). As a consequence, there was a toll of cataracts and necrosis of orbital contents necessitating enucleations or exenterations following roentgen therapy. In 3 cases our first treatment also failed, but 2 of these cases were subsequently controlled; the third patient died of cancer and 2 other patients died before the tumor had been controlled.

In evaluating the results of treatment of epidermoid carcinomas, consideration should be given to the fact that 3 of our patients presented extensive recurrences from previous treatment, and 2 others also had extensive lesions. One of these patients had a cervical metastasis; both

TABLE VI: THREE-YEAR RESULTS OF ROENTGEN THERAPY OF BASAL-CELL CARCINOMAS THAT HAD RECURRED AFTER PREVIOUS INADEQUATE TREATMENT

Total cases treated	17
Subsequent exenteration (no cancer)	1
Subsequent enucleation (no cancer)	2
Subsequent cataract	4
Subsequent necrosis	2
Subsequent recurrence (1 controlled by roentgen therapy, 1 by excision)	3
Lost to view before 3 years, without cancer	2
Dead of intercurrent diseases before 3 years	2
Dead with cancer	3
Well 3 years or more	10

the primary lesion and the metastasis were treated surgically and controlled. The other 6 patients received roentgen therapy; 3 of these died of intercurrent disease before three years; 3 remained well three years or more, including 1 in whom a pre-auricular metastasis (proved by biopsy) developed. This was treated and controlled by roentgen therapy, thus avoiding a facial paralysis.

In summary, of this series of 168 carcinomas of the skin of the orbit, 2 cases were not treated, 4 were lost to view, 25 patients died of intercurrent diseases within three years, 5 patients are known to have died or to be living with cancer, and 132 remained well three years or more, a 78 per cent absolute three-year survival.

SUMMARY

1. Carcinoma of the skin of the orbit is of more frequent occurrence in males than in females, but the proportion of women is higher than for carcinoma of the skin of the face in general.

2. About 12 per cent of all basal-cell carcinomas of the skin of the face arise from

the skin of the orbit, while only a negligible number of epidermoid carcinomas actually develop from the skin of this area.

3. Roentgen therapy is the treatment of choice of these tumors; curie therapy offers no special advantage; surgery has valuable, though secondary, indications.

4. Patients who receive inadequate treatment of any kind and later present a recurrence often require intensive or extensive treatment resulting in dysfunction or loss of the eye, as a price of their cure.

5. After roentgen therapy of 117 consecutive cases of carcinoma of the skin of the orbit not previously treated, there were 9 recurrences, all of which were subsequently controlled, and no patient died as a consequence of cancer.

Penrose Cancer Hospital
2200 Cascade Ave.
Colorado Springs, Colo.

REFERENCES

1. HUNT, H. B.: Cancer of the Eyelid Treated by Radiation, with Consideration of Irradiation Cataract. Am. J. Roentgenol. **57:** 160–180, February 1947.

2. LABORDE, S., AND BILLIARD, J.: Le traitement du cancer des paupières. Bull. Assoc. franç. p. l'étude du Cancer **29:** 59–69, January–February 1940.

3. LACASSAGNE, A.: Répartition des différentes variétés histologiques d'épithéliomas de la peau (plus particulièrement ceux de la tête) suivant les régions anatomiques, le sexe et l'âge. Ann. de dermat. et syph. **4:** 497–514, 613–640, 722–754, 1933.

4. MAGNUSSON, W.: Skin Cancer. Clinical Study with Special Reference to Radium Treatment. Acta radiol. Supp. 22, 1935.

DISCUSSION

Isadore Lampe, M.D. (Ann Arbor, Mich.): As is usually the case when one listens to a paper by Dr. del Regato, one is impressed by the skilled craftsmanship inherent in his work. My comments are few. In regard to the kind of lesion that appears in this area, our experience in general has been quite the same as that reported by Dr. del Regato. As to treatment, we have been impressed by the technical expediency of roentgen therapy. Some years ago we abandoned all other forms of radiation therapy, to treat simply with the x-ray beam. The ophthalmological surgeons who work with us have been impressed with the high quality of curative, functional and cosmetic results, so nowadays we see and treat practically all these cases in our section.

I was interested in the degree to which Dr. del Regato protracts radiation therapy. It is my impression that this degree of protraction exceeds that which we use. We generally take about a week to administer the total dose to a small lesion, although with somewhat larger lesions it may go on to two weeks. In some comparable lesions it would be still longer.

I would like to point out that in the past we were somewhat vigorous exponents of concentrated radiation: we gave a full dose, and a large dose at that, in a period of just two days. We now think we have done better by lengthening the time of administration to about a week or two. It may be that we will come to the use of still more protracted irradiation. Of course, in the large lesions we use fractional treatment, also with quite small daily doses, the total time of treatment reaching at least four weeks and possibly more.

I think this paper presents very well what can be accomplished by skillful irradiation of this type of lesion using the x-ray beam.

SUMARIO

Roentgenoterapia del Carcinoma Dermopalpebral

Esta comunicación versa sobre 168 casos de carcinoma de la piel de los párpados y de los cantos internos y externos (en 163 enfermos), observados en un período de seis años y mantenidos en observación por lo menos tres años. Los varones predominaron, pero no tanto como en el carcinoma de la piel facial en conjunto. La edad varió de 35 a 89 años. Los sitios más frecuentemente afectados fueron el párpado inferior y el canto interno. La inmensa mayoría (159) de los tumores fueron carcinomas basocelulares, habiendo además 2 carcinomas basoescamosos y 7 epidermoideos.

La roentgenoterapia es el tratamiento de elección para estos carcinomas de la piel de la órbita. El radio no ofrece mayor ventaja. La cirugía tiene sus indicaciones valiosas, aunque secundarias. El tratamiento inadecuado de cualquier género irá probablemente seguido de recurrencias que exigirán nuevas intervenciones de tal cuantía que afectarán seriamente la función del ojo

y hasta impondrán la extirpación del mismo.

En la serie descrita, 117 de los casos de carcinoma basocelular, que no habían sido tratados previamente, recibieron los rayos X. Para campos de 1.5 a 2 cm. de diámetro la dosis total fué habitualmente de 4,000 a 5,000 r (calculados en la piel sin dispersión hacia atrás), administrados durante un período de tres o cuatro semanas, de preferencia a diario. En los campos más pequeños, el tratamiento fué más prolongado y la dosis total llegó hasta 7,000 r.

En este grupo de 117 casos hubo 9 recurrencias, la mayoría en lesiones pequeñas tratadas con campos pequeños (con la consiguiente escasa dispersión posterior) y dosis totales del límite inferior de suficiencia.

No se presentó ningún caso de catarata y sólo en un caso se observó leve disminución de la visión.

Setenta y cuatro enfermos de este grupo han sido mantenidos en observación después por espacio de cinco a ocho años y medio. No hubo nuevas recurrencias después de tres años, 2 enfermos fueron perdidos de vista, 15 murieron de enfermedades intercurrentes, y 57 permanecieron bien por cinco años o más, lo cual representa 77 por ciento de sobrevivencias absolutas de cinco años con la roentgenoterapia en carcinomas basocelulares que no habían recibido tratamiento antes.

Effects of Radiation Therapy on the Urinary Excretion of Niacin and Riboflavin in Patients with Malignant Diseases

Relationship to Radiation Sickness[1]

J. L. JARVIS, M.D., and DAVID CAYER, M.D.

Winston-Salem, N. C.

CONCEPTS CONCERNING the etiology of radiation sickness have been numerous and varied. In 1906, Edsall and Pemberton suggested that the vomiting was toxic in nature and was due to unknown decomposition products of tissue destruction (5). Later, Hall and Whipple (7) attributed the effects to injury of the epithelial cells, and Rolleston (14) felt that proteins liberated by the destruction of cells were responsible for the symptoms. Holmes and Hunter noted that the manifestations closely resembled those seen in patients with catarrhal jaundice, and suggested the possibility of a disturbance of liver function as the underlying cause (8).

More recently, there has been much interest in the relationship of vitamins to radiation sickness. Martin and Moursund, in 1938, pointed out that this condition resembled a vitamin B_1 deficiency and stated that vitamin B_1 protected guinea-pigs from sickness following small doses of radiation over the abdomen (10). In the same year, Spies and his co-workers found that patients with radiation sickness, like pellagrins, have porphyrinuria (1). They stated that the administration of niacin relieved the symptoms and caused the urinary porphyrin to return to normal. They suggested that the basic disorder in x-ray sickness was a disturbance of the respiratory enzyme systems and recommended the empiric use of vitamins, especially niacin and thiamine.

In the past ten years, various purified vitamin substances have been used singly and in combination for the treatment and prevention of radiation sickness. The vitamins most frequently stated to be effective are thiamine, niacin, and pyridoxine. The good results initially reported have often proved to be short-lived, and treatment with vitamins has been shown to be of doubtful value. It seems generally agreed that the area of the body exposed to radiation and the body dose per field are significant factors. Some investigators have thought that the presence of malnutrition decreases the tolerance to radiation therapy. In most instances, however, these conclusions have been derived entirely from clinical observation and subjective impressions.

In an effort to demonstrate whether or not malnutrition predisposes to radiation sickness, we have measured the urinary excretion of niacin and riboflavin in a group of patients with malignant disease, before and after x-ray therapy. Since the vitamin deficiencies most prevalent in this area are those of niacin and riboflavin, it was felt that the urinary levels of these substances would give some indication of the patient's general nutrition. A review of the literature reveals no similar study of urinary excretion levels.

MATERIAL AND METHOD OF STUDY

Thirty subjects were taken at random from a group of unselected patients who were receiving x-ray and radium therapy for malignant disease. The group included 22 females and 8 males. The average age of the females was 55.3 years; of the males, 39 years; the average for the entire group was 50.97 years. It was felt that, in a study of this type, repeated ob-

[1] From the Departments of Radiology and Internal Medicine, Bowman Gray School of Medicine of Wake Forest College and the North Carolina Baptist Hospital, Winston-Salem, N. C. This study was supported by a grant from the John and Mary R. Markle Foundation. Accepted for publication in March 1948.

servations of the same group of subjects would be the procedure of choice.

In 28 instances (93 per cent), the presence of a malignant lesion was demonstrated by biopsy. In the remaining patients, the presumptive diagnosis was made on the basis of the x-ray findings and the clinical course. There were 23 cases of carcinoma (19 in the female genital tract, 3 in the breast, and 1 in the kidney), and 7 cases of lymphoblastoma (1 in the stomach and 6 in the mediastinum). No marked weight loss or anorexia was noted during the preliminary period of observation. None of the group received any vitamin supplement prior to treatment or during the period of follow-up. Four of the patients expired during the first year.

The radiation received by these patients was that usually advised and employed by most radiotherapists in the treatment of lymphoblastomas and carcinomas. Twenty-one patients received x-ray therapy in total dosages ranging from 1,800 to 8,120 r. Four patients received radium in dosages ranging from 3,600 to 4,800 mg. hr., and 5 patients received a combination of x-ray and radium therapy. All patients were hospitalized.

No attempt was made to estimate the dietary intake prior to admission. The social and economic status of these patients, however, was similar to that of a group studied in a previous nutrition survey and found to have an average daily intake of 9.1 to 11.8 mg. of niacin and 1.3 to 1.9 mg. of riboflavin (11).

Urinary excretion levels of niacin and riboflavin were measured before therapy was begun and, in the majority of the group, at the end of one week of therapy. Re-examinations at intervals up to a year were obtained in a smaller number of patients (Table I).

On each test day, 5 mg. of riboflavin and 50 mg. of niacinamide were given orally, and a single urine collection was made three hours after the test dose. Previous study has shown that a test dose is of greater value in demonstrating a difference between groups than the use of the routine twenty-four-hour collections. The urine was collected in dark brown glass bottles for protection against light. Glacial acetic acid and toluol were used as preservatives. The riboflavin levels were determined by the direct fluorometric method of Ferrebee, omitting the absorption and elution steps (6). The niacin determinations were done according to the method of Perlzweig for the determination of urinary F_2 (N′-methylnicotinamide) (9).

RESULTS

The excretion levels of niacin and riboflavin are shown in the accompanying table. It will be noted that the levels were relatively constant throughout the entire period of study. When the results for groups as well as for individual patients were subjected to statistical analysis, no significant difference was found in the levels obtained before, during, and after irradiation.[2] When the patients were classified on the basis of age, sex, and the site and type of malignant growth, statistical analysis revealed no significant difference between the groups. The data separated in this fashion are not included in the table.

Seven patients had nausea and vomiting at some time during the period of study. In this group, the mean excretion level of F_2 was 3.73 ± 0.67 mg., and that of riboflavin, 1125 ± 200 gamma. The averages for 15 patients who had no nausea or vomiting were 6.37 ± 0.96 for F_2 and 1713 ± 159 for riboflavin. A comparison of the values found in these two groups reveals a difference which is probably significant, although the groups are small. No difference in the amounts of food consumed was noted during the period of observation. The pre-irradiation period excretion levels served as a control for each patient.

DISCUSSION

Effect of Malignant Disease on Excretion Levels: During the period of observation,

---

[2] We are indebted to Dr. C. Nash Herndon of the Department of Medical Genetics for the statistical analyses.

TABLE I: URINARY EXCRETION OF F_2 AND RIBOFLAVIN

Time Interval →	Before Treatment	After Initiation of Therapy						
		7 Days	15 Days	21 Days	60–75 Days	100–150 Days	250–350 Days	
URINARY EXCRETION OF F_2 THREE HOURS AFTER THE ORAL ADMINISTRATION OF 50 MG. OF NIACINAMIDE								
No. of Patients	25	20	6	3	8	7	4	
Range of Excretion (mg.)	0.6–16.2	0.6–14.4	2.4–12.5	6.0–6.9	2.1–14.7	2.6–11.0	6.4–9.4	
Mean and Standard Error	5.56±0.71	5.58±0.70	5.95±1.47	6.43±0.22	5.55±1.29	5.11±1.08	7.65±0.66	
URINARY EXCRETION OF RIBOFLAVIN THREE HOURS AFTER AN ORAL DOSE OF 5 MG.								
No. of Patients	30	24	6	3	8	7	5	
Range of Excretion (Gamma)	256–2,860	526–2,538	1,360–2,640	378–2,346	560–2,418	496–2,210	1,264–3,906	
Mean and Standard Error	1,780±142	1,581±117	1,950±182	1,580±497	1,557±178	1,388±200	2,156±419	

↑
X-ray Therapy Begun

none of the patients showed any clinical evidence of a deficiency state. Four patients who expired three to six months after the beginning of therapy showed no significant change in the urinary levels of niacin and riboflavin before death. This finding might be attributed to the rapid course of the disease, although we have previously noted the maintenance of normal values even during prolonged periods of illness. The excretion levels after a test dose, as has been previously noted, are higher in patients with malignant disease than in normal individuals. This fact suggests that increased amounts of vitamins may be excreted during illness, and the niacin and riboflavin stores of the patients in the study were adequate to supply their needs and to prevent the development of the clinical signs of a deficiency during the period of observation (2).

Effect of Radiation on Excretion Levels: The excretion levels were unchanged throughout the study and were unaffected by x-ray or radium therapy. We have found in previous studies that patients who are showing marked evidence of tissue destruction, as demonstrated by weight loss and increased urinary excretion of nitrogen, often have abnormally high excretion levels of F_2. The increase appears to result from the destruction of some tissues which contribute to the rise in urinary nitrogen. The relative constancy of the urinary levels in the present series would suggest that the degree of tissue destruction resulting from x-ray or radium therapy is not sufficient to release stores of niacin. The possibility of effects due to other unmeasured products of cellular destruction still exists, however.

Relationship of Excretion Levels to Liver Function: It was hoped that the present study might clarify the possible relationship of radiation sickness to "disturbed liver function." Patients suffering from hepatic insufficiency have been shown to excrete increased amounts of F_2, apparently because of the inability of the liver to metabolize N′-methylnicotinamide (3).

The urinary levels of F_2 were not of the magnitude noted in patients with any considerable degree of parenchymatous liver disease; while routine liver function studies were not done, this finding would seem to indicate that radiation sickness is not due primarily to a disturbance of the liver's ability to metabolize these vitamins.

Correlation of Excretion Levels with Radiation Sickness: The apparent response of many patients with radiation sickness to non-specific substances has emphasized the psychic effects of therapy. Doub has reported good results following the use of calcium, morphine, glucose, and ether anesthesia (4), and uniformly satisfactory results have also been noted with nembutal and hydrochloric acid (13), with pancreatin (12), and with liver extract (16).

Bean and Spies have reported the successful use of niacin in the treatment of patients with radiation sickness (1). They found that, following radiation therapy over the upper abdomen, the urinary pigments and blood co-dehydrogenases 1 and 2 resembled those seen in severely ill pellagrins. Tests for co-dehydrogenase, biotin, riboflavin, niacin, and pantothenic acid were made on the blood before a single dose of radiation, and six and twenty-four hours afterward. No significant changes in the blood levels of biotin, pantothenic acid, riboflavin, or niacin were found. The authors felt, however, that in the patients studied there was a "rough, but by no means exact, correlation between the severity of the reaction and degree of vitamin depletion as gauged clinically."

The difficulty of recognizing early vitamin deficiencies by clinical examination alone is well known. Lowering of the concentrations of F_2 (N′-methylnicotinamide) and riboflavin in the urine is generally accepted as indicating a depletion of body stores, and precedes gross anatomic changes. It is of considerable interest that in those patients who had nausea and vomiting following x-ray theropy the excretion levels of F_2 and riboflavin were significantly reduced. The lowered levels are probably due to the previous dietary intake rather than to depletion of stores from disease or destruction by radiation therapy.

It would appear that a correlation probably does exist between the patient's state of nutrition and the tendency for nausea and vomiting to develop following radiation therapy. Patients who are in a good state of nutrition at the onset of therapy are less likely to show ill effects from x-ray or radium. Patients who can be maintained on adequate diets show no change in the excretion levels of F_2 and riboflavin as a result of radiation therapy, even when followed over a considerable period of time.

SUMMARY

Numerous hypotheses have been advanced to account for radiation sickness. A possible relationship to nutrition has been suggested, and good results have been reported following the empiric use of certain vitamins of the B complex, as well as many other non-specific substances. The actual cause of the symptoms, however, remains obscure.

The urinary excretion levels of N′-methylnicotinamide (F_2) and riboflavin were studied in patients with malignant disease before, during, and after radiation therapy. The excretion levels for all patients remained relatively constant, and in none did clinical signs of a deficiency state develop during the period of study, which in some cases was as long as a year.

Disturbances of liver function and destruction of tissue were apparently not of sufficient magnitude to be measured by the studies utilized.

The excretion levels of F_2 and riboflavin in those patients in whom nausea and vomiting developed after irradiation appeared significantly lower than the levels in the patients who suffered no ill effects from radiation.

Wake Forest College
Bowman-Gray School of Medicine
Winston-Salem 7, N. C.

BIBLIOGRAPHY

1. BEAN, W. B., SPIES, T. D., AND VILTER, R. W.: Note on Irradiation Sickness. Am. J. M. Sc. **208:** 46–54, July 1944.
2. CAYER, D.: Urinary Excretion of Niacin and Riboflavin in Patients with Acute Infections and Various Chronic Diseases. Am. J. M. Sc. In press.
3. CAYER, D.: Use of Methionine and Vitamin Supplements in Treatment of Hepatic Disease: Clinical and Laboratory Observations. Arch. Int. Med. **80:** 644–654, November 1947.
4. DOUB, H. P., BOLLIGER, A., AND HARTMAN, F. W.: Immediate Metabolic Disturbances Following Deep Roentgen-Ray Therapy; Prevention and Treatment of Untoward Reactions. J. A. M. A. **85:** 1299–1303, Oct. 24, 1925.
5. EDSALL, D. L., AND PEMBERTON, R.: The Nature of the General Toxic Reaction Following Exposure to the X-Rays. Am. J. M. Sc. **133:** 426–431, March 1907.
6. FERREBEE, J. W.: Urinary Excretion of Riboflavin; Fluorometric Methods for Its Estimation. J. Clin. Investigation **19:** 251–256, January 1940.
7. HALL, C. C., AND WHIPPLE, G. H.: Roentgen-Ray Intoxication: Disturbances in Metabolism Produced by Deep Massive Doses of the Hard Roentgen Rays. Am. J. M. Sc. **157:** 453–482, April 1919.
8. HOLMES, G. W., AND HUNTER, F. T.: Management of Roentgen Sickness. New England J. Med. **213:** 308–310, Aug. 15, 1935.
9. HUFF, J. W., AND PERLZWEIG, W. A.: A Rapid Method of Estimating N^1-Methylnicotinamide in Urine. J. Biol. Chem. **150:** 483–484, October 1943.
10. MARTIN, C. L., AND MOURSUND, W. H., JR.: Irradiation Sickness. Radiology **30:** 277–284, March 1938.
11. MILAM, D. F., AND DARBY, W. J.: The Average Diet of a Southern County and Its Effects on Nutritional Status. South. M. J. **38:** 117–125, February 1945.
12. QUIMBY, W. A.: Roentgen Sickness Controlled with Pancreatin. West Virginia M. J. **43:** 80–81, February 1947.
13. RICHARDS, G. E., AND PETERS, M. V.: Nembutal in the Treatment of Radiation Sickness. Am. J. Roentgenol. **35:** 522–525, April 1936.
14. ROLLESTON, H.: Acute Constitutional Symptoms Due to Radiations. Brit. M. J. **1:** 1–4, Jan. 6, 1923.
15. SPIES, T. D., COOPER, C., AND BLANKENHORN, M. A.: The Use of Nicotinic Acid in the Treatment of Pellagra. J. A. M. A. **110:** 622–627, Feb. 26, 1938.
16. YOUNG, B. R.: Liver Extract as a Remedy for Roentgen Sickness. Am. J. Roentgenol. **35:** 681–688, May 1936.

SUMARIO

Efectos de la Radioterapia sobre la Excreción Urinaria de Niacina y Riboflavina en los Sujetos con Enfermedad Maligna. Relación con la Enfermedad Irradiatoria

Numerosas son las hipótesis lanzadas para explicar la enfermedad de la irradiación. Se ha indicado una posible relación con la nutrición, habiéndose comunicado buenos resultados consecutivamente al empleo empírico de ciertas vitaminas del complejo B, así como de otras muchas substancias anespecíficas. Sin embargo, la verdadera causa de los síntomas permanece en el misterio.

La excreción urinaria de N′-metilnicotinamida (F_2) y de riboflavina fué estudiada en pacientes con enfermedad maligna antes y después de la radioterapia y durante la misma. Los tenores de excreción permanecieron relativamente constantes en todos los enfermos, sin que en ninguno aparecieran signos clínicos de un estado de deficiencia durante el período de estudio, que en algunos casos duró hasta un año.

La disfunción hepática y la histólisis no alcanzaron aparentemente suficiente magnitud para que las apreciaran los métodos utilizados.

Las cifras de excreción de F_2 y de riboflavina parecieron ser significativamente menores en los enfermos en que se presentaron náuseas y vómitos después de la irradiación que en los que no experimentaron efectos adversos debidos a la misma.

Anti-Histamine Ointments for Skin Protection in Radiation Therapy[1]

M. PAUL MAINS, M.D.

Trenton, N. J.

EVERY RADIOTHERAPIST knows, first, that if he is to cure a malignant tumor he must see that it receives an adequate dose of radiation and, second, that the amount that can be delivered to the tumor is limited by the normal organs and overlying skin which must be traversed by the x-ray beam.

The methods of obtaining larger tumor doses without excessive damage to normal structures are of two main types, mechanical and biological.

The mechanical means of increasing the amount of radiation reaching a tumor are well known. Increasing the focal-skin distance increases the depth dose in relation to the skin dose. Increasing the filtration up to a certain point improves the quality of the beam, which results in a more favorable depth- to skin-dose ratio. A greater focal-skin distance and increased filtration, however, require much longer treatments, which are not always feasible in a busy clinic. Where supervoltage machines with their greater output of highly filtered rays are available, treatments with radiation of excellent quality can be given in a shorter time, without serious skin damage.

Another mechanical means of increasing the tumor dose consists in cross-firing. Thus the tumor may be irradiated daily, while the intervening skin receives radiation only every second to fourth day, depending upon the number of portals used. This allows the skin a recovery period between exposures.

Of biologic methods of increasing total radiation, fractionation is well known. With proper fractionation and the use of multiple portals, tumor doses can be built up to a relatively high point and the overlying skin still be spared an irreversible reaction. Another biologic means of increasing the tumor dose is the protection of the intervening skin against severe reactions by the use of various powders, lotions, and ointments. The number of such protective applications is legion.

It is quite generally agreed that with tissue damage, histamine or histamine-like substances are released from the cells. Working on this premise, Lofstrom and Nurnberger (1) advocated the use of the new anti-histamine drugs, orally or even intravenously, when the occasion demands, to combat the systemic reaction to the product or products of cell destruction. Following a similar procedure, we have been using Benadryl and Pyribenzamine by mouth. With the routine use of 25 mg. of either drug before each meal, we have noted no adverse side effects in over 300 patients except for mild drowsiness in an occasional case. Further studies are planned to determine just what increase there is in the blood histamine during a course of intensive irradiation. It is hoped that this will suggest some explanation for the beneficial effect of these drugs in reducing radiation sickness. We do know that blood histamine values rise following a burn, and Kisima reported an increase in the histamine content of all tissues, as well as that of the blood, following cutaneous burns in dogs.

Elias and McGavack found that in man a daily dose of 150 mg. of Benadryl definitely reduced the sensitivity of the skin to histamine (2). They also noted moderately decreased capillary permeability with an alteration of the histamine wheal re-

[1] Accepted for publication in January 1948. Most of the observations upon which this paper is based were made while the author was a member of the staff of the Department of Radiology of The Henry Ford Hospital, Detroit, Mich.

action following the oral and local use of this preparation. A 5 per cent Benadryl ointment suppressed a response to histamine (3). Friedlaender and Feinberg likewise reported that the local application of Benadryl resulted in marked reduction of the wheal reaction to histamine, while Pyribenzamine had a similar but probably more potent action (4).

In view of these findings, we concluded that the local application of an anti-histamine substance should reduce the reaction of the skin to irradiation. Since Kaplan (5) reported the excellent protective qualities of Aquaphor, we have been using this as a base for both Benadryl and Pyribenzamine in 5 per cent strength. Patients are instructed to apply the ointment to all areas receiving irradiation immediately after the treatment and again at bedtime.

Using 200 k.v.p., 25 ma., 50 cm. target-skin distance, 0.5 mm. Cu plus 1.0 mm. Al filtration, with a half-value layer of 1 mm. Cu, we formerly saw reactions of intense erythema, and in some cases moist desquamation, with the usual dose of 1,800 r in air. In the pelvic region we use a 15-cm. square cone and irradiate through four portals, two front and two back, giving 200 r to each of two portals daily. Similar reactions were noted in the cervical region with 1,800 r in air, when treatment was given through a 10-cm. square portal, 300 r every second to fourth day, depending upon the number of areas being irradiated. The worst reactions, of course, were in the tissue folds of the crural regions and at the base of the neck, especially in obese patients. With the use of the anti-histamine drugs orally and in the form of an ointment applied to the treated skin, the reactions following dosages as high as 2,400 r in air, with the same factors as before, are much less than were formerly observed with 1,800 r.

The first patient on whom we used the anti-histamine ointment had carcinoma of the floor of the mouth with cervical metastases. A portal approximately 15 cm. square was used on each side of the neck and face, and the dosage to each was 2,400 r in air. Two additional small portals under the chin and over the mouth were used. In conjunction with the ointment, 25 mg. of Benadryl were given orally before each meal. The patient continued to shave daily during the course of irradiation and at no time suffered more than a mild erythema. On his return for a check-up, five months after the course was completed, the skin appeared normal, with no appreciable atrophic changes, and the beard had returned over most of the areas.

Two years ago a man was treated for lympho-epithelioma of the nasopharynx. According to one of our residents who saw him at that time, therapy had to be terminated at 1,600 r in air to each area because of an intense erythema. This patient was recently treated over the same areas, the final dosage being 2,400 r in air through each of four 10-cm. square portals. With this course and the use of oral and local anti-histamine drugs, the skin showed only a mild erythema.

A few years ago a woman was treated in our clinic after a radical amputation of the breast. She described the skin reaction as blistering and peeling. With the same amount of therapy to the opposite breast after a recent radical amputation, and with the use of the anti-histamine drugs, again locally and orally, the patient showed no appreciable erythema over any of the treated areas. She was highly appreciative of the apparent protection of the drugs during this course of irradiation.

These cases are typical of the results achieved in well over 100 cases in which the ointment has been used. Objectively the patients show a markedly increased skin tolerance to radiation. We believe tolerance has been enhanced by the local use of an anti-histamine drug, although oral administration may have some influence. Subjectively there seems to be less complaint of bowel and bladder symptoms since we have been using the anti-histamine drugs, but this is merely a clinical impression and we have no proctoscopic or cystoscopic follow-ups to substantiate it. It is known, however, that the tone and

activity of the smooth muscles of the gastro-intestinal tract are increased by histamine, and, according to Loew, this spasmogenic effect on intestinal muscle is reduced by Benadryl (6).

Animal experiments are contemplated to give proof of the protective value of these drugs to the irradiated skin, and of their value in combating the histamine produced by irradiation.

The Mercer Hospital
Trenton 8, N. J.

REFERENCES

1. LOFSTROM, J. E., AND NURNBERGER, C. E.: Irradiation Sickness: Histamine Effect Treated with Benadryl. Am. J. Roentgenol. **56:** 211–219, August 1946.

2. ELIAS, H., AND MCGAVACK, T. H.: Influence of Dimethylaminoethylbenzhydryl Ether Hydrochloride (Benadryl) upon Histamine Flare Reactions. Proc. Soc. Exper. Biol. & Med. **61:** 133–135, February 1946.

3. MCGAVACK, T. H., ELIAS, H., AND BOYD, L. J.: Influence of Dimethylaminoethyl Benzhydryl Ether Hydrochloride (Benadryl) Upon Normal Persons and Upon Those Suffering from Disturbances of the Autonomic Nervous System. Preliminary Report. J. Lab. & Clin. Med. **31:** 560–574, May 1946.

4. FRIEDLAENDER, S., AND FEINBERG, S. M.: Histamine Antagonists; Effect of Oral and Local Use of Beta-dimethylaminoethyl Benzhydryl Ether Hydrochloride on Whealing Due to Histamine, Antigen-Antibody Reactions, and Other Whealing Mechanisms: Therapeutic Results in Allergic Manifestations. J. Allergy **17:** 129–141, May 1946.

5. KAPLAN, I. I., AND RUBENFELD, S.: Use of Aquaphor in Irradiation Dermatitis. Radiology **31:** 107, July 1938.

6. LOEW, E. R., MACMILLAN, R., AND KAISER, M. E.: Anti-Histamine Properties of Benadryl, Beta-dimethylaminoethyl Benzhydryl Ether Hydrochloride. J. Pharmacol. & Exper. Therap. **86:** 229–238, March 1946.

SUMARIO

Ungüentos Antihistamínicos para la Protección de la Piel en la Radioterapia

De acuerdo con la opinión general de que al ocurrir lesiones histológicas, se desprenden de las células histamina o sustancias histaminoideas, el A. empleó las drogas antihistamínicas Benadril y Piribenzamina por vía bucal para combatir los efectos orgánicos de la irradiación. Los efectos favorables obtenidos en esa forma y las observaciones ajenas acerca del efecto del Benadril sobre la reacción histamínica de la piel indicaron que la aplicación local de un antihistamínico debe mermar la reacción cutánea a los rayos X y permitir así el empleo de dosis mayores de radiación. Por esa razón, se ha utilizado un ungüento compuesto de una base acuífera y Benadril o Piribenzamina a una concentración de 5 por ciento, junto con el antihistamínico administrado oralmente. El ungüento se aplica después del tratamiento y de nuevo a la hora de acostarse, El efecto en más de 100 casos ha sido de lo más favorable. Los enfermos muestran una tolerancia cutánea mucho mayor a la irradiación; las reacciones consecutivas a dosis hasta de 2,400 r al aire son mucho menores que las observadas anteriormente a 1,800 r.

EDITORIAL

Segmental Anatomy of the Lung

The conception of gross anatomy as a closed subject, whose investigative possibilities have been completely exhausted, has again been refuted by the studies of Boyden (1) and his associates on the segmental anatomy of the lungs. In recent years there have been two other important contributions to our knowledge of the anatomy and nomenclature of the lung. Brock's (2) work on the detailed anatomy of the lungs with particular reference to the surgery of lung abscess and pulmonary embolism has been reported in detail. Jackson and Huber (3) suggested a more rational nomenclature of the bronchi, especially as seen by the bronchoscopist. More recently, in a series of papers of great interest to all those concerned with pulmonary diagnosis and therapy, Boyden, Scannell, Hartmann, Smith, and Berg have made a most important contribution to the understanding of the anatomy of the lung.

For the first time, in the 400 odd years since Vesalius, the detailed relations of the segmental bronchi, the accompanying segmental arteries and veins have been worked out (1). At the same time Boyden has developed a simple system of numbering bronchi, arteries, and veins based on the fan-shaped arrangement of these structures and the Jackson-Huber terminology. Boyden's method of numbering the bronchi is extremely effective in correlating the segmental anatomy of the lung with what is seen in the roentgenogram of the chest, especially when the bronchi are rendered opaque by contrast media. For example, the first branch of the first (or apical) segmental bronchus of the right upper lobe is designated *B1a*, its accompanying artery *A1a*, and the vein lying caudal to it *V1a*. Other segments are treated in the same manner, so that the anterior basal bronchus of the left upper lobe is designated *B2*, the posterior *B3*, the superior branch of the lingular bronchus *B4*, the inferior branch *B5*, and so on. The cumbersome and often meaningless terminology of the older anatomy will surely be abandoned in favor of this more rational approach.

A detailed analysis of the numerous anatomical variations of the bronchi has been taken up, and in the series of papers the aberrations occurring in the upper and lower lobes are delineated. Accessory bronchi are designated as *BX*, with a number corresponding to the number of the bronchus from which they originate (4, 5, 6, 7). The anatomical hazards of various surgical procedures are thus brought out (8). Furthermore, the frequently encountered difficulties in the interpretation of bronchograms can be explained by these variations of the normal anatomy.

It is interesting to observe that Smith and Boyden (9) and Berg, Boyden, and Smith (10) have found in both the lower lobes a clinically significant subsuperior zone interpolated between the superior and basal segments in 100 per cent of the specimens. In 62 per cent of the cases this subsuperior zone is wholly or partly supplied by a dorsal branch of the stem bronchus. In the rest, the district is aerated by the highest branch of the posterior basal bronchus. The left lower lobe segment is supplied by a dorsal branch of the stem bronchus in only 28 per cent of the cases. In the remainder it is aerated by the highest branch of the lateral basal bronchus or the highest branch of the posterior basal or by both.

These examples are sufficient to indicate

the type of study which is comprised in this series of papers. Boyden and his coworkers have succeeded in mapping out the lungs in a manner previously not accomplished. A close study of their findings and the adoption of their numerical terminology should prove to be of great value in the diagnosis and treatment of many pulmonary diseases.

LEO G. RIGLER, M.D.

REFERENCES

1. BOYDEN, E. A.: Intrahilar and Related Segmental Anatomy of the Lung. Surgery **18:** 706–731, 1945.

2. BROCK, R. C.: The Anatomy of the Bronchial Tree. London, Oxford University Press, 1947.

3. JACKSON, C. L., AND HUBER, J. F.: Correlated Applied Anatomy of the Bronchial Tree and Lungs with a System of Nomenclature. Dis. of Chest **9:** 319–326, 1943.

4. BOYDEN, E. A., AND HARTMANN, J. F.: Analysis of Variations in the Bronchopulmonary Segments of the Left Upper Lobes of Fifty Lungs. Am. J. Anat. **79:** 321–360, 1946.

5. SCANNELL, J. G.: A Study of Variations of the Bronchopulmonary Segments in the Left Upper Lobe. J. Thoracic Surg. **16:** 530–537, 1947.

6. BOYDEN, E. A., AND SCANNELL, J. G.: An Analysis of Variations in the Bronchovascular Pattern of the Right Upper Lobe of Fifty Lungs. Am. J. Anat. **82:** 27–74, 1948.

7. SCANNELL, J. G., AND BOYDEN, E. A.: Study of Variations of the Bronchopulmonary Segments of the Right Upper Lobe. J. Thoracic Surg. **17:** 232–237, 1948.

8. BOYDEN, E. A.: Anatomical Hazards of Lingulectomy. Surgery **20:** 828–829, 1946.

9. SMITH, F. R., AND BOYDEN, E. A.: An Analysis of Variations of the Segmental Bronchi of the Right Lower Lobe of Fifty Injected Lungs. J. Thoracic Surg., April 1949.

10. BERG, R., BOYDEN, E. A., AND SMITH, F. R.: An Analysis of Variations of the Bronchopulmonary Segments of the Left Lower Lobe of Sixty Lungs Including Ten Injected Specimens. J. Thoracic Surg., April 1949.

11. BOYDEN, E. A.: A Synthesis of the Prevailing Patterns of the Bronchopulmonary Segments in the Light of Their Variations. To be published in Dis. of Chest, June 1949.

The Identification of Carcinoma of the Lung

The importance of the early recognition of bronchogenic carcinoma has been so thoroughly explored that it needs no further exposition here. The crucial role of roentgen examination in the early diagnosis of tumors of the bronchi is also well recognized. In the vast majority of cases the detection of the tumor is made by the observation of an abnormality in the roentgenogram of the lung, either before or after the onset of suggestive symptoms. That there are occasional, albeit rare, cases in which symptoms are present without roentgen evidence of abnormality cannot be denied. A small endobronchial lesion may give rise to sufficient bronchial irritation to cause cough, hemoptysis, and even pain, before it is of sufficient size to produce a visible abnormal shadow or sufficient obstruction to be recognizable. Much more common is the finding of roentgen signs of carcinoma without any symptoms whatever.

Despite the fact that small lesions at an early stage can be detected roentgenologically, their identification by this means is far more difficult and frequently impossible. The simulation of carcinoma by many other lesions and, conversely, the manner in which bronchogenic tumors ape the manifestations of inflammatory processes make their distinction from numerous other lung abnormalities exceedingly difficult. Such a differentiation is particularly difficult in peripheral tumors but lesions of the large bronchi, even though obstructive, may also present a problem. Yet the possibility of a cure by a radical surgical procedure makes a definite diagnosis all the more crucial.

For the solution of this problem, a number of methods have been used, none of them highly successful in the early operative cases. The most important, bronchoscopic biopsy, is notoriously unreliable in early lesions. By this means positive evidence is obtained in not more than half the cases in which surgery should be undertaken. Needle biopsy through the chest wall and exploratory thoracotomy with biopsy likewise have severe limitations. The examination of the sputum for malignant cells has been used for a number of years with very limited success.

The introduction of the Papanicolaou (1) technic in the examination of secretions

for cancer cells has opened new possibilities for the identification of carcinoma of the lung. These possibilities have been exploited to their fullest extent by Herbut and Clerf (2, 3), who have examined bronchial secretions obtained by aspiration through the bronchoscope rather than the expectorated sputum itself. This procedure is strikingly successful in their hands. In their last report (4), on 180 cases of proved bronchogenic carcinoma, they found positive evidence of malignant cells in 89.7 per cent. In the same group, positive bronchoscopic biopsies were obtained in but 39.4 per cent, and other bronchoscopic evidences of malignancy in an additional 23.3 per cent. In the experience of these workers at least, false positives are apparently rare. In a few cases the evidences of malignancy obtained by the examination of smears of bronchoscopic aspirates were observed before the appearance of any obvious roentgen signs of the disease.

More recently Woolner and McDonald (5, 6) have reported on 2,188 examinations of bronchial secretions, the smears being obtained either from sputum or from secretion obtained by bronchial aspiration. They used a hematoxylin and eosin stain. Of this group, 200 showed positive evidences of carcinoma, among which there were but 2 per cent false positives. In this series the examination was almost as effective in the cases in which the sputum alone was studied as in those in which the material was obtained by bronchoscopic aspiration.

Abundant confirmation of these results is reported in this issue of RADIOLOGY by Farber, Benioff and McGrath (7). They feel that the results of examination of the sputum are as satisfactory as those obtained from the study of bronchial aspirates.

The importance of the microscopic examination of smears of bronchial secretions in the definitive diagnosis of carcinoma of the bronchus seems to be well established. While bronchial aspirates may give a higher percentage of positives, examination of the sputum may also be of great value. In any case suspected of carcinoma of the lung in which a bronchoscopic biopsy is either obviously not feasible, as in the peripheral or high upper lobe lesions, or in which the biopsy has been inconclusive or negative, every effort should be made to obtain bronchial aspirates or sputum in order to demonstrate carcinomatous cells. The widespread use of this procedure added to routine examination of the chest by a variety of methods may well give some hope for reducing the mortality of this fatal affliction.

LEO G. RIGLER, M.D.

REFERENCES

1. PAPANICOLAOU, G. N., AND TRAUT, H. F.: Diagnosis of Uterine Cancer by the Vaginal Smear. New York, Commonwealth Fund, 1943.

2. HERBUT, P. A., AND CLERF, L. H.: Bronchogenic Carcinoma: Diagnosis by Cytologic Study of Bronchoscopically Removed Secretions. J. A. M. A. **130:** 1006–1012, April 13, 1946.

3. CLERF, L. H., AND HERBUT, P. A.: Diagnosis of Bronchogenic Carcinoma by Examination of Bronchial Secretions. Ann. Otol., Rhin. & Laryng. **55:** 646–655, September 1946.

4. CLERF, L. H.: Personal communication.

5. WOOLNER, L. B., AND MCDONALD, J. R.: Scientific Exhibit, American Medical Association Meeting, Chicago, June 21, 1948.

6. WOOLNER, L. B. AND MCDONALD, J. R.: Diagnosis of Carcinoma of the Lung. J.A.M.A. **139:** 497, Feb. 19, 1949.

7. FARBER, S. M., BENIOFF, M. A,. AND MCGRATH, A. K. JR.: Diagnosis of Bronchogenic Carcinoma by Cytologic Methods. Radiology **52:** 511–517, May 1949.

THIRD INTER-AMERICAN CONGRESS OF RADIOLOGY

As previously announced, the Third Inter-American Congress of Radiology will be held Nov. 11 to 17, 1949, in Santiago and in Viña del Mar, Chile. More than one hundred American radiologists have expressed their desire to attend the meeting and are investigating expenses, travel itineraries, reservations, etc. Information concerning these matters will be sent on application.

Arrangements are in process for the participation of United States radiologists in the program. Official topics for discussion, as previously published, are:

A. Radiological Exploration of the Cardiovascular System with Opaque Material. The official relation should refer essentially to radiological exploration of the heart and large blood vessels. Inclusion in the official presentation of the peripheral vascular system will be optional.

B. Diagnosis and Simple Radiological Explora- of the Skull. With the object of facilitating its development, this subject has been divided into three official presentations: (1) The Skull in General and the Sella Turcica; (2) The Orbits and Paranasal Cavities; (3) The Temporal Bone.

These official presentations should be short communications, read without introducing individual cases, being a résumé of the experience in the country of the speaker. Official speakers may bring all the material they wish, preferably full-size originals, for exhibition in the Scientific Exhibits. The Executive Committee requests that collaborations be fundamentally objective, and insists upon the exhibit, making the verbal part as brief as possible.

C. Radiation Treatment of Cancer of the Tongue.

D. Radiation Treatment of Cancer of the Cervix.

Official presentations on subjects *C* and *D* should comprise essentially the following parts: (1) Radiotherapy Technic; (2) Immediate and Subsequent Reactions; (3) Case Reports Illustrating Clinical Degree and the Histologic Type of Cancer.

In addition there will be opportunity for so-called "free papers," to be presented in the Section on Scientific Exhibits.

Facilities are being provided for earphones so that those in attendance will be able to hear a paper read in the language in which it is being spoken or simultaneously in translation. Our Chilean colleagues have pledged themselves to perform a tremendous amount of work to make the Congress proceedings available to all listeners.

Those who definitely decide to attend the meeting should communicate with the Regional Secretary for the United States (undersigned) for complete instructions as to the necessary documents, such as passports, visas, health certificates, etc. The inscription fee of twenty dollars ($20.00) should also be sent to the Regional Secretary. Whether or not those who inscribe as members actually attend the Congress, they will be listed as members and receive copies of the Proceedings of the Congress. Further information will be published as it becomes available. At the moment it is urged that all who wish to participate in the program make this known as early as possible.

James T. Case, M.D.
Regional Secretary
55 E. Washington St.,
Chicago 2, Ill.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

The Special Training Division of the Oak Ridge Institute of Nuclear Studies announces that three basic courses in the technics of using radioisotopes as tracers will be held during the summer. In addition, tentative plans are being made for two secondary courses in this field.

Thirty-two participants will be accepted for each of the four-week basic courses. Each session is divided into laboratory work, lectures on laboratory experiments, general background lectures, and special-topic seminars. Experiments will be conducted covering the use and calibration of instruments, and the purification and separation of radioactive materials from inert materials and from other radioactive materials. Time will also be devoted to the application of various radioisotope technics. Seminar topics will include the use of radioisotopes in animal and human experimentation, principles and practices of health-physics, design of radiochemical laboratory, dosimetry, instrumentation, and the effects of radiation on living cells.

The basic courses will be given from June 6 to July 1, July 11 to August 5, and from August 8 to September 2. Applications for these courses should be mailed prior to June 1 if possible.

The two secondary courses will be of two weeks duration and will be open to research workers who have completed the basic course or its equivalent in actual radioisotope work. One of the two courses, set tentatively for Sept. 5–16, will be devoted primarily to the use of radioisotopes in medical research. The other course, tentatively scheduled for September 19–30, will be concerned primarily with instrumentation.

A registration fee of $25.00 will be charged for the basic courses. The fee for the secondary courses has not yet been determined.

Additional information on the courses and application forms may be obtained from Dr. Ralph T. Overman, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

H. DABNEY KERR, M.D.

Dr. H. Dabney Kerr, head of the Department of Roentgenology of the State University of Iowa and one-time roentgenologist at Peking Union Medical College, is one of ten internationally known scientists recently elected to the Board of Directors of the American Bureau for Medical Aid to China.

GIFT OF DR. EMIL H. GRUBBE

Dr. Emil H. Grubbe, of Chicago, pioneer in roentgen therapy, has given his private library to The John Crerar Library of that city, according to an announcement recently issued by the Librarian. The gift, including about a thousand volumes, makes important additions to the research collection of the Library in the fields of roentgenography, roentgen therapy, and related technical subjects.

DAVID ANDERSON-BERRY PRIZE

A David Anderson-Berry silver-gilt medal, together with a sum of money amounting to about £100, will be awarded in 1950 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the therapeutic effect of x-rays on human diseases.

Applications for this prize are invited. They may be based on both published and unpublished work and should be accompanied by copies of relevant papers. They must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, by March 31, 1950.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

INDUSTRIAL FLUOROSIS. A STUDY OF THE HAZARD TO MAN AND ANIMALS NEAR FORT WILLIAM, SCOTLAND. A REPORT TO THE FLUOROSIS COMMITTEE by JOHN N. AGATE, ET AL. Medical Research Council Memorandum No. 22. Published by His Majesty's Stationery Office, London, 1949. Price 4*s*. 0*d* net. Available at the British Library of Information, 50 Rockefeller Plaza, New York.

DIE DURCHLEUCHTUNGSTECHNIK DER THORAXORGANE. By E. A. ZIMMER, Privatdozent of the University of Basel and Chief of the Roentgen Institute and Institute for Physical Therapy in the Cantonal Hospital of Fribourg. A volume of 120 pages, with 66 illustrations. Published by Benno Schwabe & Co., Basel, 2d ed., 1949. Imported by Grune & Stratton, Inc., New York.

SEGUNDA JORNADA CLINICA DE VERANO ORGANIZADA POR LA FUNDACIÓN LUCAS SIERRA, Hospital de Viña del Mar y Patrocinada por la Sociedad Medica de Valparaiso y la I. Municipalidad de Viña del Mar, Chile, Jan. 28–31, 1948. A volume of 434 pages.

CANCER. TOME II. RADIATIONS—VIRUS—ENVIRONMENT. By DOCTEUR J. MAISIN, Professeur a l'Université de Louvain, Directeur de l'Institut du Cancer à Louvain. A volume of 308 pages. Published by Casterman, Tournai–Paris, 1949. Price 120 francs.

GENETIC-STATISTICAL AND PSYCHIATRIC INVESTIGATIONS OF A WEST SWEDISH POPULATION. By Torsten Sjögren. Acta psychiatrica et neurologica, Supplementum 52. Published by Ejnar Munksgaard, Copenhagen, 1948. Price 15 Dan. crowns.

Book Reviews

AN ATLAS OF MYELOGRAPHY. Prepared for the Registry of Radiologic Pathology, American Registry of Pathology, National Research Council. From Material in the Files of the Neurological Institute of New York. By ERNEST H. WOOD, JR., M.D., Assistant Professor of Radiology in the College of Physicians and Surgeons, Columbia University; Assistant Attending Radiologist to the Presbyterian Hospital in the City of New York. A volume of 114 pages, with 42 figures. Published by Registry Press, Washington, D. C., 1948. Price $5.00.

As its initial publication, the Registry of Radiologic Pathology, the most recently organized branch of the American Registry of Pathology, sponsored by the three national radiological societies, has issued a modest atlas devoted to myelography as an aid in studying lesions of the vertebral canal.

With the exception of the first chapter, or section, as the author has chosen to call it, on the technic of myelography, and a single page at the end of the volume on the differential diagnostic value of the procedure, the text is largely limited to description of the myelograms, which are, of course, the main feature of the work. Sections on the normal myelogram and on possible errors in technic are followed by representative cases of spinal cord tumors, lesions of the intrathecal spaces, and extradural lesions. Brief clinical histories are included in each instance.

Neurosurgeons and roentgenologists who wish a compact, conveniently handled atlas of normal and abnormal myelograms will find it in this slight volume.

PRACTICAL SPECTROSCOPY. By GEORGE R. HARRISON, PH.D., SC.D., Professor of Physics, RICHARD C. LORD, PH.D., Associate Professor of Chemistry, AND JOHN R. LOOFBOUROW, SC.D., Professor of Biophysics, of the Spectroscopy Laboratory, Massachusetts Institute of Technology. A volume of 606 pages, with numerous illustrations and tables. Published by Prentice-Hall, Inc., New York 11, N. Y., 1948. Price $6.65.

This volume on *Practical Spectroscopy* from the Massachusetts Institute of Technology more than adequately fulfills the purpose for which it was written, *viz.*, to "help the worker in any branch of science to evaluate the aid which the techniques of spectroscopy might lend to the solution of his own problems." Although the later chapters of the book present considerable material of value to the theorist, even this is presented in a way which will be advantageous to the practical spectroscopist. The organization of the book and the data it contains make it of particular value to the institution considering the installation of spectroscopic equipment for the first time. It brings together material which is of interest to one who is well acquainted with the subject but who may be using the methods for the first time in applied or pure research.

Under one cover there is presented a complete listing of present-day commercial spectrographic equipment, together with descriptions and photographs, providing readily the information which heretofore was obtainable only by the study of a number of older textbooks, by reviewing commercial descriptive material, by interviewing users and manufacturers, and by visiting spectrographic laboratories.

It is apparent that the book is not meant to be a self-sufficient reference work, for it does not contain as complete spectrographic tables as are to be found elsewhere, nor are there tables or sets of charts of the complete iron spectrum. It is hardly a textbook in the usually accepted sense of the word, but should be very valuable as a source of information and explanation concerning the application of spectroscopy.

In Memoriam

ARIAL WELLINGTON GEORGE, M.D.
1882–1948

In the passing of Arial Wellington George of Boston, who died at Brooks Hospital in Brookline, Mass., on Dec. 24, 1948, the radiologic world has lost another of its fast disappearing pioneers.

Arial George was born on Nov. 5, 1882, in Yonkers, New York. As he approached maturity he chose the field of medicine for his life work. After receiving preparatory training at Tilton Academy, he entered Tufts College and was graduated from its medical school in 1906. In that same year he was made assistant instructor in anatomy at Tufts, assistant instructor in pediatrics at Harvard, and roentgenologist to the Children's Hospital. All these posts he filled with distinction for eight years or more. Eventually (1921) he was to become professor of radiology in Tufts College Medical School for two years, and later (1926) to be the recipient of the honorary degree of Doctor of Science from Tufts College.

A long and impressive list of achievements and honors bears witness to the high place Dr. George held in his profession. In 1916, when the United States was on the verge of entering the first World War, he was appointed major in the Medical Reserve Corps of the Army, at that time a relatively high rank, and he was one of the youngest majors in the Medical Corps. Presently he was given command of one of the six schools of military roentgenology, and later was chosen as director of the school at Fort Riley, Kansas, for intensive training of medical officers in military roentgenology. To this

Arial W. George, M.D.

task he gave his best efforts until the school was closed in the fall of 1918.

In 1923 the British Institute of Radiology invited him to give the Sir James MacKenzie-Davidson Memorial Lecture in London and bestowed upon him the coveted Sir James MacKenzie-Davidson Memorial Medal. He was the first American to receive this honor. A few years later he received an honorary diploma in radiology from Cambridge University.

At the time of his death Dr. George was radiologist to the Brooks Hospital, the Glover Memorial, and the Infirmary of the Massachusetts Institute of Technology. He was also consultant at the Attleboro, Cape Cod, and Lynn Hospitals, and in previous years he had served as consultant in radiology to the Boston Dispensary, Boston City Hospital, New England Hospital for Women and Children, and the Forsyth Dental School.

He was a charter member, fellow, and past chancellor of the American College of Radiology; member of the American Roentgen Ray Society, the Radiological Society of North America, the New England Roentgen Ray Society, of which he had been president, and American Medical Association.

Books of which Dr. George was author (with Ralph D. Leonard) included *Roentgen Diagnosis of Surgical Lesions of the Gastro-Intestinal Tract*, *The Vertebrae Roentgenologically Considered*, and *The Pathological Gallbladder, Roentgenologically Considered*. In addition, he contributed many important papers to the literature of radiology.

Dr. George, the practising radiologist, gave superior service to his patients and referring physicians. Enthusiastic and thorough in his work, he was a stickler for meticulous technic and roentgenograms of superlative quality. By such technics he was able to obtain shadows of pathologic gallbladders before the advent of cholecystography, a feat that few other examiners could accomplish. It was perhaps in this field and that of gastrointestinal diagnosis that he gave greatest service to his specialty.

Arial George the man was social, colorful, intensely human. He belonged to the Harvard Club and the Wellesley Club and was a 33rd degree Mason. He was devoted to his family, the now bereft wife and two young sons. Like that of other men of note, his character also had distinctive markings. Highly sensitive, confident of the fairness and validity of his personal views, he regarded any opposing opinion as a challenge to debate which he gladly accepted. Furthermore, he enjoyed provoking arguments with his friends, and in these debates and friendly encounters his attack and repartee fairly sparkled with brilliance. His many admirers perceived his intrinsic merits, and those of us who knew him well and were proud to count him as our good and loyal friend join in a fond and respectful salute to his memory.

B. R. KIRKLIN, M.D.

Vincent J. Moore, M. D.

VINCENT J. MOORE, M.D.

With the death, on Nov. 19, 1948, of Dr. Vincent J. Moore, radiologists of western New York lost one of their most respected associates. Dr. Moore had been an active and energetic member of the Buffalo Radiological Society, the American College of Radiology, and of the Radiological Society of North America.

Dr. Moore was born in Buffalo, March 17, 1897, and was a life-time resident of that city. He attended Canisius College and was graduated from the University of Buffalo School of Medicine in 1923. Subsequently, he served his internship at the Broad Street Hospital in New York City,

After a number of years in the practice of general medicine, which afforded him an excellent background for his later interest in radiology, Dr. Moore undertook special training at the Boston City Hospital and Peter Bent Brigham Hospital. Following this, he returned to Buffalo and in 1936 was appointed radiologist to the Mercy Hospital, a position which he occupied ably and conscientiously until his death. He was also consultant in radiology for Our Lady of Victory Hospital, Lackawanna, N. Y.

Dr. Moore's efforts on behalf of radiology and his primary interest in the advancement of medicine were centered in the community which he served, and his contributions to his specialty were most deeply appreciated by those with whom he was closely associated. Particularly will his loss be felt by the Buffalo Radiological Society.

MARIO C. GIAN, M.D.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. D. Anderson, M.D., 2501 6th St., Tuscaloosa.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Wybren Hiemstra, 1414 S. Hope St. Meets monthly, second Wednesday, County Society Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, Charles E. Grayson, M.D., Medico-Dental Bldg., Sacramento 14. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Ivan J. Miller, M.D., 49 Fourth St. Meets monthly on the third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Mark S. Donovan, M.D., 306 Majestic Bldg., Denver 2. Meets third Friday of each month, at the Colorado School of Medicine and Hospitals.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Robert M. Lowman, M.D., Grace-New Haven Hospital, Grace Unit, New Haven. Meetings bimonthly, second Thursday.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, Alfred A. J. Den, M.D., 1801 K St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Auditorium.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, F. K. Hurt, M.D., Riverside Hospital, Jacksonville. Meets in April and in November.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. W. Bryan, M.D., 490 Peachtree St., N. E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, T. J. Wachowski, M.D., 310 Ellis Ave., Wheaton. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April, at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Harold L. Shinall, M.D., St. Joseph's Hospital, Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Anthony F. Rossitto, M.D., Wichita Hospital, Wichita. Meets annually with State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Everett L. Pirkey, M.D., 323 East Chestnut St., Louisville 2.

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at Louisville General Hospital.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, J. Howard Franz, M.D., 1127 St. Paul St., Baltimore 2.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, George Belanger, M.D., Harper Hospital, Detroit 1. Meetings first Thursday, October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Meets in Spring and Fall.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ralph C. Moore, M.D., Nebraska Methodist Hospital, Omaha 3. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston. Meets monthly on third Friday at Boston Medical Library.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary-Treasurer*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Raphael Pomeranz, M.D., 31 Lincoln Park, Newark 2. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Abraham H. Levy, M.D., 1354 Carroll St., Bklyn. 13. Meets fourth Tuesday of each month, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary-Treasurer*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings in January, May, and October.

LONG ISLAND RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening, October to May, at 8:45 P.M., in Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Wm. Snow, M.D., 941 Park Ave., New York 28.

QUEENS ROENTGEN RAY SOCIETY. *Secretary*, Jacob E. Goldstein, M.D., 88-29 163rd St., Jamaica 3. Meets fourth Monday of each month.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Ralph E. Alexander, M.D., 101 Medical Arts Bldg., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 1338 Second St., N., Fargo.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Carroll Dundon, M.D., 2065 Adelbert Road, Cleveland 6. Next meeting at annual meeting of the State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., Grant Hospital, Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Seneca Hotel, Columbus.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Eugene L. Saenger, M.D., 735 Doctors Bldg., Cincinnati 2. Meets last Monday, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Merthyn A. Thomas, M.D., 10515 Carnegie Ave., Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Boyd Isenhart, M.D., 214 Medical-Dental Bldg., Portland 5. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Arthur Finkelstein, M.D., Graduate Hospital, Philadelphia. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, R. P. Meader, M.D., 4002 Jenkins Arcade, Pittsburgh 22. Meets second Wednesday of each month at 6:30 P.M., October to June.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr. Next meeting in Denver, Colo., Aug. 18–20, 1949.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer* Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets during Annual Session of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months.

HOUSTON X-RAY CLUB. *Secretary*, Curtis H. Burge, M.D., 3020 San Jacinto, Houston 4. Meetings fourth Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Homer V. Hartzell, M.D., 310 Stimson Bldg., Seattle 1. Meetings fourth Monday, October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day meeting in May; one-day with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 P.M., September to May, Service Memorial Institute, Madison 6.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542, Santurce, Puerto Rico.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS *Honorary Secretary-Treasurer*, E. M. Crawford, M.D., 2100 Marlowe Ave., Montreal 28, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA, *General Secretary*, Dr. Dionisio Pérez Conio Marsella 11, México, D. F. Meetings first Monday of each month.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

HERDNER, R. Rules and Conditions of Visibility in Osseous Tomography 595

LINDGREN, ERICK. Pneumographic Study of the Temporal Horn, with Special Reference to Tumors in the Temporal Region 595

MILLER, DOUGLAS, AND FLEMING, JUSTIN. Intracranial Hydatid Disease, with Report of a Case 595

ECKER, ARTHUR. Erosion of the Anterior Clinoid Processes Simulating That Due to Intrasellar Tumor. A Diagnostic Pitfall 595

WYATT, J. P., AND GOLDENBERG, H. Craniolacunia. Report of Six Cases, with a Review of the Literature 595

DEVOE, ARTHUR G. Fractures of the Orbital Floor 596

EAGLE, WATT W. Elongated Styloid Process. Further Observations and a New Syndrome 596

MARROCCO, WILLIAM A. Multiple Osteoma of the Mastoid Cavity 596

BEYER, T. E., AND BLAIR, J. R. Sublingual Rhabdomyoma 596

The Chest

PENTA, ARTHUR Q. Role of Bronchoscopy in Clinical Medicine and Surgery 596

LEE, J. H. Diagnosis of Tuberculosis in the Presence of Silicosis 597

ALLISON, CHARLES R. Prognosis in Pulmonary Tuberculosis. A Ten Year Follow-Up Study 597

TRIMBLE, HAROLD G., ET AL. Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis: 407 Consecutive Cases 597

MAURER, GUSTAV. Bloodless Wide Drainage of Cavities and Its Therapeutic Application ... 598

POLLAK, M., NEUER, HANS, AND GOLDSCHMIDT, HEINZ. Tuberculosis in the Mentally Ill and Defective. A Preliminary Report 598

DICK, W. POINTON. Yearly Re-Examination of a Factory Group by Mass Radiography 598

BIGGS, ALFRED D., AND RIGBY, RALPH G. Nontuberculous Pulmonary Calcification 598

HARVEY, WILLIAM A. Pulmonary Brucellosis ... 599

HEATON, T. G. Cardiospasm with Associated Pulmonary Disease 599

SMITH, ADELAIDE R., AND PERINA, ARTHUR E. Pneumoconiosis from Synthetic Abrasives 599

SPAIN, DAVID M., AND LESTER, CHARLES W. Time Element in the Development of Irreversible Bronchiectasis 599

KJELLBERG, SVEN R. A Previously Unreported Sign of Foreign Bodies in the Trachea 600

NIELSEN, KAREN. A Case of Multiple Tracheal Diverticula 600

HOWES, WILLIAM E. Bronchial Adenoma 600

EVANDER, LEONARD C. Pleural Fat Pads. A Cause of Thoracic Shadows 600

LLOYD, MILTON S. Tumors of the Anterior Mediastinum 600

AKMAN, LEONARD C. Mediastinal Mass Simulating Enlarged Heart, Intracardiac Catheterization in Diagnosis 601

KJELLBERG, SVEN R. Mediastinal Abscess Diagnosed by Roentgen (Puncture under Fluoroscopic Control and Injection of a Water Soluble Contrast Medium) 601

WELCH, C. STUART, ETTINGER, ALICE, AND HECHT, PAUL L. Recklinghausen's Neurofibromatosis Associated with Intrathoracic Meningocele 601

STROUD, WILLIAM D., STROUD, MORRIS W., III, AND MARSHALL, DAVID S. Measurement of the Total Transverse Diameter of the Heart by Direct Percussion 601

MASTER, ARTHUR M. Apical Systolic Murmur .. 602

CARSON, MERL J., AND BURFORD, THOMAS H. Diagnosis and Surgical Treatment of Certain Congenital Cardiovascular Anomalies 602

CASTELLANOS, AGUSTÍN, AND GARCÍA, OTTO. An Erroneous Conception of the Trilogy of Fallot 602

FISCHMANN, E. J., AND GWYNNE, F. J. The Heart in Rheumatoid Arthritis 602

PRINZMETAL, MYRON, ET AL. Studies on the Coronary Circulation. Collateral Circulation of Beating Human and Dog Hearts with Coronary Occlusion 603

The Digestive System

WASCH, MILTON G., AND MARCK, ABRAHAM. Radiographic Appearance of the Gastrointestinal Tract During the First Day of Life 603

KENWORTHY, ROGER A., AND WELCH, C. STUART. Leiomyoma of the Esophagus and Cardia of the Stomach 604

SINGLETON, A. C. Radiological Aspects of Peptic Ulcer 604

COHN, ALLAN L., AND GOLD, RUBIN L. Prepyloric Spasm Simulating Gastric Malignancy .. 605

PELLINI, MARIA, AND ORLANDI, NOEL. Stenosis of the Duodenum Caused by Enteroperitonitis During Fetal Life 605

LORBER, STANLEY H., AND MACHELLA, THOMAS E. Enteric Cyst of the Duodenum. Report of a Case and Review of the Literature 605

WILKERSON, JAS. HERBERT, AND COFFMAN, ROBERT. Multiple Diverticula of Jejunum 605

DELARIO, A. J. X-Ray Examination of the Vermiform Appendix 606

COURT, DONALD, AND MATHESON, NORMAN M. Pancreatic Calculi 606

ZUCKERBROD, MORRIS, ET AL. Amebic Liver Abscess 606
KJELLBERG, SVEN R. Water Soluble Contrast Medium for the Precise Roentgenological Diagnosis of Cysts of the Common Bile Duct 607

The Musculoskeletal System

FAIRBANK, H. A. THOMAS. Osteopetrosis. Osteopetrosis Generalisata, Marble Bones, Albers-Schönberg's Disease, Osteosclerosis Fragilitas Generalisata 607
HINCHEY, JOHN J., HINES, EDGAR A., JR., AND GHORMLEY, RALPH K. Osteporosis Occurring During Potassium Thiocyanate Therapy for Hypertensive Disease 608
HUTTER, CHARLES G., JR. New Concepts of Osteomyelitis in the Newborn Infant 608
SEAR, H. R. Engelmann's Disease. Osteopathia Hyperostotica Sclerotisans Multiplex Infantilis 608
HAUSER, EMIL D. W., AND CONSTANT, GEORGE A. Skeletal Hemangio-Endothelioma 608
BAKER, WILLIAM J., ET AL. Eosinophilic Granuloma. Report of a Case With X-Ray Evidence of Rapid Progression 609
AISNER, MARK, AND HOXIE, THOMAS B. Bone and Joint Pain in Leukemia Simulating Acute Rheumatic Fever and Subacute Bacterial Endocarditis 609
DE MAESTRI, ALFREDO. Peri-articular Calcifications in Lymphatic Leukemia 609
TORGERSEN, JOHAN. Anomalies of the Spine in Anomalies of Viscera and Constitution 609
NORCROSS, JOHN R. Compression of the Spinal Cord Due to Direct Extension from a Tuberculous Pulmonary Abscess 609
BARNES, ROLAND. Paraplegia in Cervical Spine Injuries 610
TAYLOR, ALEXANDER R., AND BLACKWOOD, WILLIAM. Paraplegia in Hyperextension Cervical Injuries with Normal Radiographic Appearances 610
SCOVILLE, WILLIAM B., MORETZ, WILLIAM H., AND HANKINS, WALTER D. Discrepancies in Myelography. Statistical Survey of 200 Operative Cases Undergoing Pantopaque Myelography 610
STENSTRÖM, RASMUS. Widening of the Root Defect in Lumbar Myelogram by Abrodil ... 611
DEHLINGER, KLAUS R. Salmonella Osteomyelitis of the Spine Associated with Abdominal Aortic Aneurysm 611
SOMERVILLE, E. W., AND WISHART, J. Pott's Disease of the Spine with Rupture of the Aorta 612
OLSSON, OLLE. Roentgendiagnostic Points of View on Spinal Tumours in Children 612
SPITZER, RICHARD, AND PRICE, L. WOODHOUSE. Solitary Myeloma of Mandible 612
ANDREASEN, A. T. Congenital Absence of the Humeral Head 612
BURROWS, H. JACKSON. Fatigue Fractures of the Fibula 612
FANG, HSIEN-CHI. Periostitis of the Os Calcis. An Osteo-Periosteal Manifestation of Rheumatoid Arthritis 613

Gynecology and Obstetrics

DALSACE, JEAN. Radiologic Study of Uterine Evacuation 613
KULCSAR, DAVID D. Chinese Maternal and Fetal Measurements 613
MELODY, GEORGE F. Opisthotonos Fetalis in Breech Presentation 614

The Genito-Urinary System

HOFFMAN, HOWARD A. Massive Hydronephrosis. 614
KRETSCHMER, HERMAN L. Renal Rickets and Polycystic Disease of the Kidney 614

The Blood Vessels

GROSS, SIDNEY W. Cerebral Arteriography 615
RAYMOND, G. H., ADAMS, G. T., AND MCCORRISTON, J. R. Venography in the Normal and Pathological Leg 615
BULL, DAVID C. Phlebography of the Lower Extremity 615
FISHER, MARTIN M., AND RITZ, NORTON D. Thrombosis of the Inferior Vena Cava Due to Hypernephroma 616
SMITH, BEVERLY C., AND QUIMBY, EDITH H. Radioactive Sodium in Peripheral Vascular Disease Studies 616

Miscellaneous

MCLEAN, GEORGE, AND LEBO, LESTER. Multiple Calcinosis Associated with Hypervitaminosis D 616
WEBER, HARRY M. Roentgenologic Evidence of Biliary Regurgitation: Roentgenologic Contributions to the Diagnosis of Hypoparathyroidism; Appendicitis; Mesenteric Thrombosis 616

RADIOTHERAPY

DRIPS, DELLA G. Ovarian Dysfunction in Young Women Treated with Low-Dosage Irradiation 616
LONG, ALBERT E. Hemothorax in Relation to Benign Pelvic Tumors 617
KEYES, EDWARD L. Epithelial Bladder Tumors Attacked by Radons and Fulguration During the Years 1926–1938 617
SAUER, HANS R., WATSON, ERNEST M., AND BURKE, EUGENE M. Tumors of the Testicle 617
CHAMBERLAIN, RICHARD H., AND PENDERGRASS, EUGENE P. Treatment of Hemangiomas ... 618
SOBEL, A., AND SOBEL, P. Radiotherapy for Plantar Warts 618
RUCH, DONALD M. Ringworm of the Scalp. Review of 100 Cases 618

RADIATION EFFECTS

COURT BROWN, W. M. Value of Platelet Counts in Radiotherapy 618
CAHAN, WILLIAM G., ET AL. Sarcoma Arising in Irradiated Bone. Report of Eleven Cases .. 619
HOCK, CHARLES W., ET AL. Radiation Injuries of the Intestines 619
JOHNSTON, JAMES R., AND JACOX, HAROLD W. Rectal Hemorrhage Following Irradiation for Carcinoma of the Cervix 619
UNDERWOOD, G. B., AND GAUL, L. EDWARD. Disfiguring Sequelae from Radium Therapy. Results of Treatment of a Birthmark Adjacent to the Breast in a Female Infant 620

EXPERIMENTAL STUDIES

PICCOLO, GIACINTO, AND LONGO, GIUSEPPE. Experimental Pyelorenal Reflux 620
SCHILLER, M. A. Bone Changes in the Cat in Experimentally Produced Injury to the Peripheral Nerves 620
HIRSCHFELDER, J. O., MAGEE, J. L., AND HULL, M. H. Penetration of Gamma-Radiation Through Thick Layers. Plane Geometry, Klein-Nishina Scattering 620
HIRSCHFELDER, JOSEPH O., AND ADAMS, EDWARD N., II. Penetration of Gamma-Radiation through Thick Layers. Plane Geometry, Iron, and Lead 620

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Rules and Conditions of Visibility in Osseous Tomography. R. Herdner. J. de radiol. et d'électrol. **29:** 123–130, 1948. (In French)

The physical aspects of the technic of tomography, with particular reference to the skull, are discussed in detail.

Ten illustrations, including 4 tomograms.

RODERICK L. TONDREAU, M. D.
The Mayo Foundation

A Pneumographic Study of the Temporal Horn, with Special Reference to Tumors in the Temporal Region. Erick Lindgren. Acta radiol., Suppl. 49, 1948.

As his medical Dissertation before the Karolinska Institute, Stockholm, Erick Lindgren presents a report of studies conducted at the Seraphimer Hospital of that city on the temporal horn and tumors of the temporal area. It is based on a combined study of the shape of the temporal horn as observed at autopsy and radiological observations on anatomical specimens, as well as studies of 137 cases brought together from the Radiological Department and the Neurosurgical Clinic of the hospital since the publication of Lysholm's *Das Ventrikulogram* from that institution in 1935–37.

A full abstract of the contents is not possible here. The first part of the work takes up the anatomy and radiological appearances of the normal temporal horn, as well as the deformities resulting from intracranial expanding lesions. The second part consists of four chapters dealing respectively with Infratemporal Tumors, Meningiomas from the Sphenoidal Ridge, Gliomas of the Temporal Lobe, and The Reliability of Pneumography. A comprehensive bibliography completes the work.

Two hundred and thirty-nine figures, including 88 roentgenograms.

Intracranial Hydatid Disease, with Report of a Case. Douglas Miller and Justin Fleming. Australian & New Zealand J. Surg. **17:** 291–296, April 1948.

Intracranial hydatid disease is a rare condition, most often reported in children. The signs of a space-occupying lesion are usually present; the skull may be misshapen and some thinning of the overlying bone may be demonstrable roentgenographically. Ventriculography may be necessary for diagnosis, though it carries a risk of rupture of the cyst and secondary infestation.

Since there is little reaction of the nervous system to the presence of the cyst, there is usually but poor development of the adventitious membrane or ectocyst. Daughter-cyst formation is unusual. In the case reported here, however, daughter cysts were present in large numbers, and the adventitia was well developed and calcified, producing a roentgen picture which made possible a presumptive preoperative diagnosis.

The patient was a boy of eight years who had had some association with sheep dogs. He gave a history of convulsions and of headaches and a recent hemiparesis. Following roentgen demonstration of the calcified ectocyst, an exploratory operation was performed. Evacuation of the parent cyst led to relief of symptoms, but a relapse occurred in six weeks. A second operation removed all hydatid tissue, but the patient died. An evaluation of all clinical and postmortem data indicated that a sterile meningitis followed the first operation and that basilar meningitis ensued, producing an internal hydrocephalus.

The paper is illustrated with films of the skull showing the calcified cyst, ventriculograms showing dilatation and displacement of the lateral ventricles related to the basilar meningitis and the hydatid cyst, and films showing the parent cyst and a communicating daughter cyst filled with air.

Six illustrations.

JAMES ALLAN READ, M.D.
The Henry Ford Hospital

Erosion of the Anterior Clinoid Processes Simulating That Due to Intrasellar Tumor. A Diagnostic Pitfall. Arthur Ecker. Arch. Neurol. & Psychiat. **59:** 523–528, April 1948.

A case is reported of erosion of the anterior clinoid processes as a complication of a posterior fossa tumor. Roentgenograms of the skull revealed enlargement of the sella, erosion of the posterior clinoids and dorsum sellae, and erosion of the under surface of each anterior clinoid process. This led to a diagnosis of intrasellar tumor. An angiogram of the right side of the brain showed upward displacement of the middle cerebral artery throughout its course. Ventriculograms revealed dilatation of both lateral ventricles and of the third ventricle. Moreover, there was angulation of the aqueduct characteristic of a posterior fossa tumor. This latter was confirmed surgically. Postoperatively the patient showed steady improvement.

The probable sequence of events is reconstructed. The enlarging cerebellar tumor caused compression, kinking, and blockage of the aqueduct, with a consequent internal hydrocephalus. Enlargement of the third ventricle resulted in posterior displacement and erosion of the posterior clinoid processes. Ballooning of the lateral ventricle produced elevation of both the anterior and the middle cerebral artery, which in turn caused traction on the terminal (supraclinoid) segment of the internal carotid artery. Thus, the pulsating artery came to erode the inferomedial aspect of each anterior clinoid process.

One roentgenogram; 1 drawing.

EDWARD E. LEVINE, M. D.
Dearborn, Mich.

Craniolacunia. Report of Six Cases, with a Review of the Literature. J. P. Wyatt and H. Goldenberg. Arch. Path. **45:** 667–677, May 1948.

Six cases of craniolacunia seen in the course of a year are reported. All were associated with hydrocephalus and overt defects of the brain and cord. The diagnosis of this anomaly is made during life by roentgenography or at autopsy by direct inspection, transillumination, or roentgen study.

This paper is devoted chiefly to a pathological consideration of the condition. It is believed that more detailed autopsy studies may reveal a greater incidence of neuro-embryologic defects and shed further light on the histologic aspects and the causation.

Two roentgenograms; 2 photomicrographs; 2 photographs.

Fractures of the Orbital Floor. Arthur Gerard DeVoe. Arch. Ophth. **39:** 595–622, May 1948.

This paper consists largely of a discussion of the treatment of fractures of the orbital floor. The importance of these fractures in the production of the condition known as traumatic enophthalmos has been recognized as a result of improvement of roentgenographic technic. Depressed fractures of the orbital floor are not infrequently overlooked, even when associated with more obvious depressions in the orbital rim. This has been particularly true in the presence of severe injuries or war wounds, in which the patient's condition is so critical that little attention is paid to what at the moment is of secondary importance. The residua of such injuries may later assume considerable importance from the standpoint either of ocular dysfunction or of cosmetic appearance. All of the 34 patients in the present series had sustained injury several months prior to the author's first observation.

Failure to detect the condition roentgenographically is more often to be attributed to lack of correct technic than to inexperience or carelessness in interpreting the results. It is impossible to evaluate the condition of the orbital floor from routine roentgenograms of the skull. All the patients in the present series had stereoscopic roentgenograms taken in both the Caldwell and Waters positions. Lateral views were obtained in all cases and, in many, roentgenograms of the optic canal as well. In the author's experience, the Waters position has been most valuable in determining the presence and extent of the deformity in the orbital floor. Single films are of little value, since they frequently yield a picture hardly distinguishable from that of sinusitis. Stereoscopically, however, the downward bulging of the orbital floor is clearly demonstrated. The degree of prolapse of the orbital contents has been said to be greater when the antrum is large. This is logical but was not specifically noted in this series.

Six roentgenograms; 10 photographs; 4 drawings; 2 diagrams.

Elongated Styloid Process. Further Observations and a New Syndrome. Watt W. Eagle. Arch. Otolaryng. **47:** 630–640, May 1948.

Since 1937 the author and his associates have observed 254 cases with clinical symptoms due to an elongated styloid process. Patients are classified into two groups, those with the typical syndrome and those with the carotid artery syndrome.

Typical Syndrome: The typical syndrome is seen in patients who have undergone tonsillectomy and develops during the post-tonsillectomy convalescence. Scar tissue formation stretching the nerve ending is thought to be the cause of the symptoms. The ninth cranial nerve is most often affected, with occasional fifth nerve and rare seventh and tenth nerve involvement. The tautness of the pharyngeal mucosa over the process can easily stimulate these nerve endings as movements of the pharynx occur. The patient complains of a constant pain or a nagging dull ache in the pharynx; a pain frequently referred to the ear, indicating irritation of the vagus nerve; increased salivation; hesitancy and difficulty in swallowing; gagging; a sensation of a foreign body—even cotton—in the pharynx. A spasm or contraction of the constrictor muscles of the esophagus and the pharynx may be observed.

Carotid Artery Syndrome: In the present series, about 12 patients complained of pain beginning in the neck at a point about opposite the tonsillar fossa and extending upward over the side of the head in a pattern conforming to the distribution of the external or internal carotid artery. One patient in this group was operated upon, and the existence of the carotid artery syndrome was thus definitely established. In these patients the author believes the elongated process points either medially, causing pressure and some obstruction of the internal carotid artery, or laterally, impinging on and impairing the circulation in the external carotid artery.

The diagnosis of elongated styloid process should be suggested by the patient's history. It is confirmed by the palpating finger. When the tonsils have been removed, there is no question of the diagnosis if a firm bony resistance is met in the tonsillar fossa, especially at the upper pole. Roentgenograms are taken merely for confirmation of the diagnosis but are of considerable aid as a guide in the surgical shortening of the process.

The actual length of the elongated process is determined on the lateral roentgenogram. This enables the surgeon to decide just how much should be removed. The postero-anterior view shows any deviation of the entire process, including the tip, which cannot be recognized in the lateral view.

Treatment of the elongated styloid is entirely surgical. Many elongated processes produce no symptoms and operation is advised only if symptoms are severe.

Three roentgenograms; 1 drawing; 2 photographs.

Multiple Osteoma of the Mastoid Cavity. William A. Marrocco. Arch. Otolaryng. **47:** 673–677, May 1948.

Osteoma of the mastoid process is observed infrequently, and the author could find no case in the literature similar to the one here recorded, in which the osteoma was multiple and located within the mastoid cavity, arising from the inner table of the mastoid process, and not on the external cortex. Roentgenograms showed a well developed normal pneumatic mastoid bone on the left side. On the right, there was a large "expanding lesion," containing six separate osteomas. The diagnosis was confirmed at operation.

Six roentgenograms; 3 photographs.

Sublingual Rhabdomyoma. T. E. Beyer and J. R. Blair. Arch. Otolaryng. **47:** 678–680, May 1948.

A case of sublingual rhabdomyoma in which sialography was of considerable value in the differential diagnosis is reported. A course of roentgen irradiation (dosage not given) was without appreciable benefit, and the tumor was removed by blunt dissection. Several weeks after the operation, another tumor was discovered in the left hypopharynx, and this also was removed. Histologic examination revealed a rhabdomyoma in both instances.

Two roentgenograms; 2 photographs.

THE CHEST

Role of Bronchoscopy in Clinical Medicine and Surgery. Arthur Q. Penta. Dis. of Chest **14:** 366–385, May-June 1948.

Bronchoscopy has come to play an important role in the diagnosis and treatment of pulmonary diseases. The author discusses its diagnostic use in (1) carcinoma of the lung; (2) benign neoplasms; (3) bronchial stenosis resulting from inflammatory reactions produced by foreign bodies, specific infections, and congenital ten-

dencies; and (4) the presence of non-opaque foreign bodies. He also describes, under the heading *Mechanics of the Bronchial Tract*, the varying changes following the aspiration of a non-opaque foreign body: inflammation, partial obstruction, obstructive emphysema, and atelectasis. The importance of early removal of the foreign body while the pulmonary changes are reversible is stressed. They may cease to be reversible if the atelectasis is allowed to exist for a period of time.

In the field of therapy (1) lung abscess, (2) bronchiectasis, (3) postoperative atelectasis, (4) bronchial asthma, (5) massive pulmonary hemorrhage, and (6) endobronchial tuberculosis are discussed. Bronchoscopy as an aid to thoracic surgery is also considered.

Close co-operation between the internist, radiologist, and bronchoscopist will in many instances facilitate the diagnosis of obscure conditions of the lung. In the diagnosis of primary carcinoma of the lung, bronchoscopic examination is held to be by far the most important diagnostic procedure available.

Eighteen illustrations, including 10 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Diagnosis of Tuberculosis in the Presence of Silicosis. J. H. Lee. Canad. M. A. J. **58:** 349–353, April 1948.

The author lists the common symptoms and signs of simple silicosis and comments upon the changes that these may undergo in the presence of a complicating tuberculosis. Dyspnea, for example, becomes more severe due to increasing fibrosis and toxicity. Cough, usually unproductive in simple silicosis, becomes productive, with sputum varying from a thick, tenacious mucus to a foul purulent material. Suggestive of tuberculosis, also, are chest pain, hemoptysis, weakness, loss of weight, night sweats, limited chest expansion on one side, râles, and temperature elevation.

Except in patients who are acutely ill, tuberculosis can usually be ruled out by a negative tuberculin reaction (dose of 10 mg.). Demonstration of the tubercle bacillus in the sputum is, of course, positive evidence of infection, but this is particularly difficult in the presence of silicosis.

Radiologically, certain changes in the picture are helpful in the diagnosis of tuberculosis. The characteristic picture of silicosis is one of nodular shadows scattered through both lung fields. As the nodulation progresses, the hilar shadows and linear markings seen in the early stage of involvement recede. When simple silicosis has become infected the hilar shadows persist; the margins of the nodules are no longer well defined but are fluffy or indistinct; the nodules increase in size and tend to meet and coalesce, forming larger shadows, which represent the most characteristic evidence of tuberculosis. The presence of cavitation usually indicates tuberculosis, though ischemic necrosis in the central part of a silicotic fibrotic area may produce an excavated area. Dense shadows indicative of silicotuberculosis are commonly found in the upper mid-lung fields and the hilus. Large oval or circular masses may be present, with radiating lines extending into the remaining lung tissue. These tail-like extensions tend to reach downward to the base, often to the diaphragm, producing the typical tented appearance. Thickening of the pleura, obliteration of the costophrenic angles and pleuropericardial adhesions are common findings. In the remaining lung tissue a compensatory emphysema develops, usually basal in distribution. Deviation of the trachea is especially suggestive of tuberculosis.

The author reviews 100 cases giving statistical studies of many factors. He presents briefly four case histories.

Four roentgenograms; 9 tables.

BERNARD S. KALAYJIAN, M.D.
Detroit, Mich.

Prognosis in Pulmonary Tuberculosis. A Ten Year Follow-Up Study. Charles R. Allison. Occup. Med. **5:** 379–390, April 1948.

The author presents observations made on the course of pulmonary tuberculosis in a group of employees with clinical and/or roentgenographic evidence of the disease who were followed for ten or more years at the Eastman Kodak Co., Rochester, N. Y. No attempt is made to eliminate by pre-employment roentgenograms of the chest persons in whom active pulmonary tuberculosis might develop. At present, more than 2 per cent of all employees have roentgen evidence of pulmonary tuberculosis considered to be arrested or inactive.

During the ten-year period January 1938 to January 1948, 2,348 persons were continuously employed. Of this number, 93 had roentgenographic signs indicating minimal or moderately advanced pulmonary tuberculosis either when employed or when the first roentgenogram was taken. All of these had periodic x-ray examinations of the chest over at least ten years, every six months to three years, depending on the relative "hardness" of the lesion. Eighty-five employees, most of whom worked more than twenty years, never had clinical evidence of active infection. The serial roentgenograms of the majority in this group showed changes in minimal lesions from relative "softness" to resolution, calcification, or contraction over the years. In 8 persons active pulmonary tuberculosis actually developed, requiring time away from work. In 4 other employees active infection developed some time after the pre-employment film showed no evidence of active disease.

Serial roentgenograms are reproduced to show the development of an asymptomatic active infraclavicular lesion in a young woman in whom bilateral infiltration of the upper lobes of the lungs was considered to have appeared "hard" nine months previously. Another series of films illustrates the development of a moderately advanced lesion with cavitation four years after the patient had pleurisy with effusion, with almost spontaneous healing. The cavity closed in about two months, and the patient had worked for eighteen years, after being absent only three months.

It was found that active pulmonary tuberculosis may develop after long periods (upwards of ten years) of apparent inactivity. It may appear in persons with "negative" roentgenograms of the chest as late as the forty-fifth year of life. Relatively short periods of treatment for a minimal lesion are sufficient to return most persons to their usual work. The incidence of relapse is low.

Twenty-four roentgenograms; 3 tables; 1 chart.

Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis: 407 Consecutive Cases. Harold Guyon Trimble, J. Lloyd Eaton, Gerald L. Grenshaw, and Ina Gourley. Am. Rev. Tuberc. **57:** 433–470, May 1948.

An analysis of the results of pneumoperitoneum therapy in 407 consecutive cases of pulmonary tuberculosis

is given. The material is presented in the form of tables, together with case reports and reproductions of roentgenograms. In 57 per cent of the patients the disease became arrested, and an additional 13 per cent were definitely improved. Complications of sufficient severity to cause discontinuance of the pneumoperitoneum occurred in 6 or 7 per cent, depending upon the point of view.

Contraindications to pneumoperitoneum therapy are relatively few. They include (1) heart failure, (2) a moribund state or extreme toxicity, (3) pregnancy, (4) large abdominal tumor. The purpose of the procedure is to achieve an adequate mechanical rise of the diaphragm, thus reducing the pulmonary volume and limiting diaphragmatic motion with ordinary respiration. For maintenance, large weekly refills are necessary; this is done under fluoroscopic guidance.

It is concluded that this method of treatment is a valuable collapse procedure in the treatment of pulmonary tuberculosis.

Twenty-four roentgenograms; 13 tables; 2 graphs.

L. W. PAUL, M.D.
University of Wisconsin

Bloodless Wide Drainage of Cavities and Its Therapeutic Application. Gustav Maurer. Schweiz. med. Wchnschr. **78:** 345–349 April 17, 1948. (In German)

While the open drainage of cavities permits their collapse, the use of Monaldi's method has very serious complications, such as puncture of major arteries with hemorrhage, "spontaneous" pneumothorax, or phlegmon of the chest wall. The author, therefore, prefers an operative technic. The cavity is carefully localized by tomography and is entered first with a needle and then with a rubber catheter. This is sealed to the chest wall and, as granulations form, is gradually removed. Meantime, constant suction drainage is employed. As a last step, the open cavity is packed with streptomycin-impregnated gauze, and is allowed to granulate in. Unlike Monaldi's method, this procedure is most successful in the presence of bronchial occlusion. Indications are the presence of a cavity the size or location of which makes the success of either extrapleural pneumothorax or thoracoplasty doubtful; cavitation occupying the entire apex; paravertebral or parasternal cavities of the middle or lower lobe; the presence of respiratory or cardiac insufficiency in addition to cavity; the additional presence of extrapulmonary foci.

Four roentgenograms; 5 photographs.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Tuberculosis in the Mentally Ill and Defective. A Preliminary Report. M. Pollak, Hans Neuer, and Heinz Goldschmidt. Illinois M. J. **93:** 260–268, May 1948.

The high incidence of tuberculosis in the mentally ill and defective is a well established fact. Because of this, a tuberculosis control program covering all mental institutions in the state of Illinois was put into operation in 1940. Newly admitted patients and new employees are routinely examined roentgenographically and check-up films are obtained once a year if at all possible.

A study of one of the state mental institutions (Drake Hospital) from 1943 to 1947 showed that during that period there were 147 patients who had tuberculosis; there were 53 deaths from the disease, in 48 it became arrested, and 45 patients were still under treatment. Films for 42 of the 53 patients were available for study. It was found that the time interval between diagnosis and death was less than three months in 6 cases, from two to six months in 2 cases, six months to a year in 12, between one and two years in 18, and from three to five years in 4.

X-ray examination of the mentally ill and defective presents many technical difficulties. The spinal and chest deformities so common in mental defectives present a bizarre film that is sometimes impossible to read.

Although roentgenology is not an exact science, and the reading of chest films is subject to a "personal equation," the authors admit they are essential in the diagnosis of tuberculosis.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Yearly Re-Examination of a Factory Group by Mass Radiography. W. Pointon Dick. Brit. M. J. **1:** 680–691, April 10, 1948.

The findings of four annual resurveys of a factory population are analyzed. The workers had had no preemployment x-ray study and the yearly fluorographic examination was entirely voluntary. The total number examined each year declined steadily, which somewhat detracts from the significance of the results. The object of this analysis, however, was to determine if the interval of a year was suitable for such survey work. The percentages of suspicious and definitely pathological cases did diminish to what is probably an almost irreducible minimum, indicating, to the satisfaction of the author, that the interval was suitable.

The new cases seen each year represent new workers or disease contracted since the previous films. One case is cited in which a worker previously examined showed, on re-examination, far advanced disease of a fulminating type. She is representative of the unfortunate ones who have no resistance to the infection and in whom treatment is of no avail.

Four tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Nontuberculous Pulmonary Calcification. Alfred D. Biggs and Ralph G. Rigby. J. Pediat. **32:** 393–396, April 1948.

Fourteen children, from three to fourteen years of age, both white and Negro, with clearly negative tuberculin tests and calcium deposits in the chest were studied in the Outpatient Department of St. Luke's Hospital, Chicago. Bronchoscopy was done in all of the group. The mucous membrane at the bifurcation and in the main bronchi in 9 was described as somewhat abnormal, though these changes were neither striking nor characteristic of any known disease. In all but one of the cases, aspirated secretion was injected into a guinea-pig. Ten of the animals lived the usual eight weeks, were killed, and autopsied, but none had tuberculosis. The other three died prematurely of other infections.

Calcium deposits were demonstrated roentgenographically at one or both hili in every patient. One child showed calcification in the right third interspace not unlike a Ghon tubercle. In no instance were the calcium deposits heavy.

One patient had Boeck's sarcoid involving the lungs, without cough, and in this case only were acid-fast bacilli demonstrated in the aspirated secretion. A

thorough clinical study, including bronchoscopy and bacteriologic study of the aspirated secretions, failed to produce any evidence that the remaining 13 children had or had had a tuberculous infection. Eight of the 13 had a history of frequent colds or persistent coughs. Six of the 12 who were skin-tested gave an immediate reaction to histoplasmin.

It is suggested that a mild subclinical histoplasmosis may be one cause of non-tuberculous pulmonary calcification. Ordinary recurrent respiratory infections may be another.

Pulmonary Brucellosis. William A. Harvey. Ann. Int. Med. **28**: 768–781, April 1948.

Two cases of chronic diffuse pulmonary involvement attributed to brucellosis are recorded. The review of the literature which is presented suggests that these cases are instances of a characteristic clinical course, marked by perihilar lymphadenopathy, bronchitis or pneumonitis of prolonged duration, and usually spontaneous subsidence with resorption of fibrosis, all of which stages have been reported in previous studies.

In the first case, a routine chest film taken in 1945 showed evidence of chronic interstitial fibrosis. This prompted further roentgen study, which revealed throughout both lung fields, from apices to bases, but particularly between the second and sixth interspaces, a process involving the interstitial tissues above the terminal bronchioles and apparently causing a marked cellular infiltration and moderate fibrosis. Three months later these findings were unchanged. The patient did not consider herself ill, but questioning elicited a history of lymphadenopathy in 1942, which had now largely regressed, a sustained fever through 1942 and the first half of 1943, and respiratory complaints (persistent cough and chest pain) in the early months of 1943. A routine chest film in 1942 had shown "marked hilar lymphadenopathy."

In the second case there was a history of cough and roentgen evidence of parenchymal infiltration in the lungs, leading first to a diagnosis of tuberculosis.

In neither case was *Brucella* recovered from the blood, but blood cultures in chronic brucellosis are commonly negative. Agglutination tests were positive in both patients, and in the second a positive skin text was obtained. The first patient gave a history of ingestion of raw milk; no mention of this is made in the second case.

Five roentgenograms.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Cardiospasm with Associated Pulmonary Disease. T. G. Heaton. Dis. of Chest **14:** 425–426, May-June 1948.

Cardiospasm predisposes to aspiration of foreign material into the lungs, and subacute or chronic pulmonary disease may subsequently develop. The author gives the case history of a 51-year-old female who had a non-tuberculous pulmonary fibrosis secondary to cardiospasm, symptoms of which had first appeared twenty-seven years earlier. The roentgen picture was characteristic, showing chronic pulmonary infiltration and the esophagus curving downward and inward from the left apex.

Two roentgenograms. HENRY K. TAYLOR, M.D.
New York, N. Y.

Pneumoconiosis from Synthetic Abrasive Materials. Adelaide Ross Smith and Arthur E. Perina. Occup. Med. **5:** 396–402, April 1948.

In roentgenologic surveys conducted by the division of industrial hygiene of the New York State Department of Labor it has been a not unusual experience to observe nodular shadows strongly suggesting silicosis in the lungs of metal grinders who use "carborundum" wheels. While the question of the etiologic role of "carborundum" was posed in these cases, the possibility, or even the probability, that the shadows were due to the deposit of iron dust could not be eliminated.

More illuminating was the survey made in a plant engaged in the grinding of silicon carbide and aluminum oxide for abrasive purposes. Here too, nodular shadows were observed in the roentgenograms of the chests of employees, but in these cases no iron dust was present to complicate the roentgen picture by the production of siderosis. In this plant silicon carbide and aluminum oxide in bulk form, both containing less than 1 per cent free silica, were received by railroad car from another plant where these synthetic abrasives were manufactured. Approximately equal amounts of the two materials were handled. The chief sources for creation of dust were in shoveling, in leakage from the various conveyor systems, in the filling of barrels, and from generally poor housekeeping.

The chests of 53 employees of this plant were examined roentgenographically. Of the films, 34 revealed nothing abnormal; 1 showed cystic disease of the lungs; 3 showed healed primary tuberculosis, while 15 showed some pulmonary fibrosis, in 7 of a nodular type resembling silicosis. All but one man in the latter group had worked in the plant for more than ten years. In one case, previous employment in a foundry for nine years could well account for the presence of a second-stage silicosis. One gave a history of previous exposure to asbestos dust, but the appearance of the roentgenogram was not characteristic of asbestosis. Two other men gave a history of exposure to coal and wood dust, but this exposure would not have produced silicosis, though it possibly played an aggravating role. Three men had had no previous exposure to dust.

In discussing the effect of carborundum in the reactivation of healing tuberculous lesions, Gardner (Pub. Health Rep. **45:** 282, 1930) speculated whether the alkaline body fluids may be able to free silica from its combination in silicon carbide. J. W. Clark, in a paper read before the Industrial Hygiene Foundation (Mellon Institute), in 1942, stated that "if through gross negligence heavy clouds of fine dust have been inhaled over a period of many years, the amount of scar tissue may be considerable. The deposited dust may fill portions of the lung and provoke by its mechanical irritation a real fibrotic reaction. Such a condition could not occur unless the worker was doing dry grinding with no exhausts for many years." The present study indicates that further pathologic studies should be made of the behavior of "carborundum" dust in the lungs, including analysis of pulmonary tissue for free silica after the inhalation of "carborundum."

Three roentgenograms; 2 tables.

Time Element in the Development of Irreversible Bronchiectasis. David M. Spain and Charles W. Lester. J. Pediat. **32:** 415–419, April 1948.

Bronchiectasis may be the result of infection behind a partial obstruction in the bronchus. As the result of the

suppurative lobular pneumonia, the bronchial wall becomes necrotic, with the eventual destruction of the musculo-elastic coat. It has been thought that if the obstruction is relieved early, before the inflamed bronchus is significantly damaged, healing may occur, with restoration of practically normal bronchial structure. There are only a few recorded cases in which an accurate determination can be made as to the length of time for the process to become irreversible.

The authors record the case of a five-year-old boy who aspirated a small screw. Attempts to remove the screw by bronchoscopy were unsuccessful. Lobectomy was performed fifty-one days later. Bronchiectatic changes were present and histologic examination showed varying degrees of destruction of the bronchi and bronchioles. It is concluded that early destruction of the musculo-elastic layer of the lung precludes the possibility of a reversibility of bronchiectasis.

Two roentgenograms; 2 photomicrographs.

A Previously Unreported Sign of Foreign Bodies in the Trachea. Sven Roland Kjellberg. Acta radiol. **29:** 300–302, April 30, 1948.

In cases where a non-opaque foreign body lodges in the trachea, *inspiratory* collapse of the segment below the foreign body and simultaneous widening of the air passages above it indicate the location of the obstruction at the junction of these two contrasting areas. This previously unreported sign is demonstrated by films made on a one-year-old child who had inhaled a piece of bark. On expiration the lower portion, which collapses on inspiration, returns to normal or widens slightly. These changes are readily visualized on the x-ray films.

Three roentgenograms; 1 photograph.

STANLEY H. MACHT, M.D.
Baltimore (Md.) City Hospital

A Case of Multiple Tracheal Diverticula. Karen Nielsen. Acta radiol. **29:** 331–334, April 30, 1948.

A case of multiple tracheal diverticula diagnosed by bronchography is reported and a brief discussion of the condition is included. Tracheal diverticula can be divided into three groups.

1. Congenital diverticula are always situated on the right side of the trachea at the site of tripartition of the bronchial tree and are believed to represent an extra rudimentary apical bronchus.

2. Acquired diverticula are flask-shaped, usually with a narrow inlet. They are found in the central third of the trachea at the junction of the cartilaginous and the membranous portions and usually contain mucus.

3. Diverticulum-like protrusions of the posterior wall occur in the upper part of the trachea or may even involve the entire wall. They are assocated with tracheal widening and dilatation of the bronchial tree. The case reported was of this third type. As is usual in this type, the patient gave a long history of respiratory disease.

Two roentgenograms.

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospitals

Bronchial Adenoma. William E. Howes. Dis. of Chest **14:** 427–436, May-June 1948.

Of all the benign intrabronchial tumors, the adenoma is most common. The clinical findings depend upon the degree of obstruction. When the tumefaction is small there may be no signs. When there is a partial block with a ball-valve action, emphysema develops distal to the block. With a complete block, atelectasis occurs. The symptoms are usually those of repeated attacks of cough associated with chills and fever. The cough may be persistent and unproductive. Hemoptysis may occur during a coughing seizure. Conditions to be differentiated are tuberculosis and bronchogenic carcinoma.

The author gives two case histories. In one, an associated pituitary adenoma was diagnosed four years after the original diagnosis of a bronchial adenoma; in the second case an associated benign papillary adenoma of a kidney was found. Because of the presence of multiple adenomata in these two cases, the author speculates on a possible inherited weakness in the ectodermal structures.

Benign polypoid intrabronchial tumors are easily recognized on bronchoscopy. The microscopic findings are characteristic. Treatment is endoscopic fulguration or lobectomy.

Fourteen illustrations, including 5 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Pleural Fat Pads. A Cause of Thoracic Shadows. Leonard C. Evander. Am. Rev. Tuberc. **57:** 495–503, May 1948.

The literature on the subject of pleural fat pads is reviewed and three cases are presented, together with illustrative roentgenograms to show the appearance of this finding. In the normal parietal pleura, fatty cushionings of various stages of development may occur. This padding can be extensive, forming a roof-like covering on the inner surface of the ribs. These pads appear to be of common occurrence and of some practical importance in roentgenologic diagnosis. They may be observed both on postero-anterior and lateral chest films. The pads appear as areas of hazy density along the chest wall, and may be somewhat lobulated. In patients with pneumothorax, they can be better visualized and are rather easily recognized roentgenographically. In one of the author's cases the fat pad interfered with the induction of pneumothorax and the insertion of a thoracoscope.

Five roentgenograms.

L. W. PAUL, M.D.
University of Wisconsin

Tumors of the Anterior Mediastinum. A Report of Six Cases. Milton S. Lloyd. Dis. of Chest **14:** 396–414, May-June 1948.

Six cases of anterior mediastinal tumor are reported: one lipoma, one lymphangioma, one undifferentiated embryonal tumor, and three teratomas. In five cases there was a long silent period and the presence of the tumor was signalized by complications which added to the difficulties of management. In these cases, surgical treatment resulted in clinical cures. The remaining case, in a newborn infant, caused an obstructive dyspnea and death.

Early diagnosis of these tumors is important and can be accomplished only by roentgenography. The author believes that, while mass surveys and prompt use of the x-ray for minor symptoms is the accepted procedure in the field of tuberculosis, not enough prominence has been given to application of the same concept to the realm of other diseases. "Comparatively speaking, early diagnosis is of greater importance in nontubercu-

lous than in tuberculous disease involving the organs of the chest."

Streptomycin and parachlorophenol proved useful in treatment of a pyocyaneus infection in one case.

Twenty-five illustrations, including 16 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Mediastinal Mass Simulating Enlarged Heart, Intracardiac Catheterization in Diagnosis. Leonard Carl Akman. Ann. Int. Med. **28:** 1048–1057, May 1948.

A case of anterior mediastinal tumor is presented which is unusual both for the diagnostic problem posed and for the use of intracardiac catheterization in its solution.

The patient was a fifteen-year-old girl complaining of recurrent chest pain. Roentgen examination showed apparent enlargement of the heart, especially to the right; the border was uninterrupted, and the shadow homogeneous in density. Fluoroscopically, normal pulsations were observed on both sides. The esophagus was in normal position, without constriction. In order to differentiate between an extracardiac mass and cardiac enlargement, it was decided to pass a catheter as a probe into the right heart. If the catheter approached the right border of the shadow, the latter could then be assumed to represent the heart. The catheter was accordingly introduced by way of the median basilic vein of the right arm but, once in the heart, it showed a tendency to straighten out on approaching the left side. It was then decided to introduce it from the opposite side, when, as expected, its tendency to straighten caused it to hug the right cardiac border. A bulge was outlined in the wall of the right auricle continuous with the outer border of the mediastinal shadow, from which it was evident that a mass was impinging on the auricle.

A right pneumothorax was done as a further diagnostic measure in anticipation of surgery. This procedure was even more revealing than intracardiac catheterization. X-ray examination now showed part of the true right border of the heart extending below the border of a mass. Fluoroscopically one could differentiate the active pulsations of this small part of the heart from the pulsations transmitted to the mass. It was also seen that the mass was suspended by a pedicle from a point above the right auricle.

At operation, a globular dermoid cyst about the size of a large orange was found. It was adherent to the pericardium. The mass was successfully removed.

Had artificial pneumothorax preceded intracardiac catheterization, the need of the latter would have been obviated, but past experience has not always found artificial pneumothorax as conclusive as in the present instance. Intracardiac catheterization offers another procedure to be added to the armamentarium of the diagnostician. This is believed to be the first reported instance of the use of the catheter as a probe.

Six roentgenograms.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Mediastinal Abscess Diagnosed by Roentgen (Puncture under Fluoroscopic Control and Injection of a Water Soluble Contrast Medium). Sven Roland Kjellberg. Acta radiol. **29:** 294–299, April 30, 1948.

The author reports a case of mediastinal abscess diagnosed by means of mediastinal puncture and injection of contrast medium into the abscess cavity. The procedure is described as follows:

The patient was first given a barium swallow for the purpose of localizing the abscess. A fine needle was inserted into the right supraclavicular fossa and directed downward and medially. Resistance was felt when the abscess wall was reached. When the needle was in the abscess cavity a small amount of radiopaque medium was injected through the needle to verify its location within the cavity. A large amount (15 c.c.) was then injected into the cavity a little at a time, after first withdrawing a similar amount of pus, to prevent increased intracavity pressure. In the roentgenogram the abscess cavity is outlined by the radiopaque medium.

Eight roentgenograms; 1 drawing.

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospitals

Recklinghausen's Neurofibromatosis Associated with Intrathoracic Meningocele. Report of a Case. C. Stuart Welch, Alice Ettinger, and Paul L. Hecht. New England J. Med. **238:** 622–625, April 29, 1948.

A 41-year-old woman was known to have Recklinghausen's neurofibromatosis and an intrathoracic tumor. Roentgenographic study of the chest showed a mass in the left mediastinum, with widening of the sixth intercostal space and erosion of the adjacent ribs and vertebrae. There was marked kyphoscoliosis at this level. A diagnosis of paravertebral intrathoracic tumor, probably neurofibroma, was made. Operation revealed a cystic mass containing clear fluid. It was then evident that a meningocele was present and this was resected. Recovery was uneventful.

In a review of the literature, the authors found three previous reports of *intrathoracic* meningocele, two of which were associated with Recklinghausen's disease. All three patients died at operation.

Anterior meningoceles are rather uncommon, the condition being more frequent in the sacral region, less so in the cervical and lumbar region, and least of all in the thoracic region. The diagnosis of intrathoracic meningocele may be made on evidence of a tumor eroding the vertebral bodies and adjacent ribs, at the level of a kyphosis, and by myelographic study.

Four roentgenograms.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Measurement of the Total Transverse Diameter of the Heart by Direct Percussion. William D. Stroud, Morris W. Stroud, III, and David S. Marshall. Am. Heart J. **35:** 780–786, May 1948.

The authors elected to determine the total transverse diameter of the heart by percussion and check their findings against measurements obtained by teleroentgenographic examination. Three hundred and thirty-three examinations were made on 305 males. Seventy-four per cent of the measurements were within ± 10 per cent, and 88 per cent were with ± 15 per cent, of those obtained by x-ray; 58 per cent were within 1.0 cm. and 89 per cent within 2.0 cm. of the x-ray measurements. In 208 instances the percussion measurements were smaller and in 118 larger than those obtained radiologically.

Fifty-five examinations were made on 45 females. Of the percussion measurements, 64 per cent were within ± 10 per cent, and 80 per cent were within ± 15 per

cent, of the x-ray measurements. In 58 per cent the deviation was within 1.0 cm. and in 90 per cent within 2.0 cm. Twenty-nine percussion measurements were greater and 17 were less than the corresponding radiologic measurement.

A discussion of the possible sources of error in both methods of examination is included.

Two photographs; 4 charts.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Apical Systolic Murmur. Arthur M. Master. Arch. Int. Med. **81:** 518–533, April 1948.

A loud systolic murmur at the apex should be considered organic in nature until it can be proved otherwise. It should be kept in mind constantly that the sound of the murmurs varies; they may be loud in one examination and not audible in the next, and they vary with alteration in the position of the patient. They may disappear for weeks, months, or years and then reappear. They may vanish permanently. In the evaluation of apical systolic murmurs, the loudness or the intensity of the murmur is of more significance than its transmission.

The diagnostic signs to be sought in physical examination are a loud first apical and a loud second pulmonic sound. A prolonged murmur is significant. A "musical," "seagull," "harsh," or "constant" murmur tends to confirm the presence of organic disease. Patients should be examined repeatedly, in different positions and after exercise. Such careful investigation may disclose not only a loud systolic murmur but also a diastolic murmur. It is only in cases of advanced heart disease that one finds a distinct systolic thrill, enlargement of the heart, diastolic murmurs, abnormal electrocardiograms, and signs of heart failure.

Two signs of beginning mitral valve deformity are to be seen in roentgenograms and on fluoroscopic examination. In the left oblique position the space beneath the left main bronchus is filled by the enlarging left auricle. In the postero-anterior view the left border of the heart may be "straight," a result of prominence in the region of the pulmonary artery. Only in long established disease of the mitral valve does one find cardiac enlargement, elevation of the left main bronchus produced by the large left auricle, a left auricular arch far over on the right side of the heart, or indentation of the barium-filled esophagus.

The phonocardiogram may prove helpful in establishing the duration of a systolic murmur and may demonstrate an otherwise inaudible diastolic murmur. The electrocardiogram is most helpful in the diagnosis of advanced involvement of the mitral valve, but occasionally when there is early impairment it reveals abnormal auricular waves and right axis deviation.

Neurocirculatory asthenia frequently offers a problem in differential diagnosis. Funnel and flat-shaped chests and kyphoscoliosis involving the right dorsal area often cause symptoms which simulate those of rheumatic involvement of the mitral valve. Inspection of the chest, roentgenograms, and fluoroscopy demonstrate the deformity. The diagnostic characteristics of hypertension, hyperthyroidism, and anemia, which may produce loud apical systolic murmurs, demarcate them from disease of the mitral valve.

Five roentgenograms; 3 electrocardiograms; 1 phonocardiogram.

Diagnosis and Surgical Treatment of Certain Congenital Cardiovascular Anomalies. Merl J. Carson and Thomas H. Burford. J. Pediat. **32:** 495–515, May 1948.

A review of congenital cardiovascular anomalies now amenable to surgical treatment, with a consideration of the embryology, anatomy, physiology, and differential diagnosis, is concisely presented. The surgical procedure of choice in each case is indicated, with pertinent remarks. The anomalies described include patent ductus arteriosus, coarctation of the aorta, pulmonary stenosis, and anomalies of the aortic arch.

The use of an oximeter, a photoelectric cell device for the measurement of the oxygen saturation of the blood, is described. Examples of typical curves for otherwise obscure anomalies, especially those involving the pulmonary circulation, are given.

Illustrative roentgenograms supplement the general radiographic description in most cases. Angiocardiograms are advised where of value, but the criteria for diagnosis by this means are not fully presented.

Eighteen illustrations, including 13 roentgenograms.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

An Erroneous Conception of the Trilogy of Fallot. Agustín Castellanos and Otto García. Rev. cubana de pediat. **20:** 261–267, May 1948. (In Spanish)

What was described by Fallot in 1888 as a trilogy was actually a double anatomical defect, namely, pulmonary stenosis and patency of the foramen ovale, with *normal* development of the interventricular septum. Perhaps by a misunderstanding or an error of translation, most of the pediatricians and cardiologists of Europe and America describe the trilogy of Fallot as follows: pulmonary stenosis, interventricular communication, and patency of the foramen ovale. The authors point out this fact in the hope that in the future this error will disappear from the medical literature.

JAMES T. CASE, M.D.
Chicago, Ill.

The Heart in Rheumatoid Arthritis. E. J. Fischmann and F. J. Gwynne. Brit. Heart J. **10:** 125–134, April 1948.

In an attempt to settle the question of the frequency of cardiac lesions in rheumatoid arthritis, the authors made a study of 60 patients in whom other etiological factors of heart disease could be ruled out and whose rheumatoid arthritis was unquestionable. Only 3 patients showed clinical evidence of heart disease. Ungerleider and Clark's prediction tables were used as criteria of enlargement.

On radiologic examination, 23 per cent of the series showed some cardiac enlargement. In 50 per cent of this number enlargement was left ventricular, in 21 per cent left ventricular and left auricular, and in 29 per cent generalized. There were no instances of predominantly right-sided enlargement. The striking feature of the group was the absence of clinical or electrocardiographic manifestations of heart disease. It was thought probable that radiologically manifest cardiac enlargement in rheumatoid arthritis is either an expression of chronic rheumatic carditis or a form of cardiac involvement due to the etiologic factor of rheumatoid arthritis.

Eight roentgenograms; 3 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Studies on the Coronary Circulation. III. Collateral Circulation of Beating Human and Dog Hearts with Coronary Occlusion. Myron Prinzmetal, H. C. Bergman, H. E. Kruger, Lois L. Schwartz, Benjamin Simkin, and Sidney S. Sobin. Am. Heart J. **35:** 689–717, May 1948.

Recent investigations have demonstrated anatomic evidence of anastomotic channels in the normal human heart. These communications comprise the basis of a potential extensive collateral circulation. Three different types of experiments were performed to gain an insight regarding the functional role of the collateral circulation during life, immediately after acute coronary occlusion.

1. Human red cells labelled with radioactive phosphorus were injected into moribund patients shortly before death. At autopsy, the heart was removed and the distribution of the radioactive red cells was quantitatively determined by the Geiger counter and radioautographs, in arbitrarily chosen portions of the heart. In hearts with myocardial infarction, the radioactivity in the region of infarction was compared with the radioactivity in the uninvolved contiguous myocardium. In addition, a radiopaque mixture was injected into the right and left coronary arteries and a routine radiograph made, so that these vessels could be identified. The course of these arteries was then superimposed upon the radioautograph for orientation.

In normal human hearts, and in arteriosclerotic human hearts with myocardial infarction, the radioactive red cells were distributed evenly throughout the ventricular myocardium in the infarcted as well as in the uninvolved myocardium. These findings demonstrate the presence of a functioning collateral circulation to all parts of a myocardial infarction in the arteriosclerotic heart in living man.

2. The above experiment was repeated in dogs after occlusion of the anterior descending branch of the left coronary artery. The collateral circulation to the ischemic or potentially infarcted myocardium was studied after injecting radioactive dog erythrocytes. Two controls were also studied. Radioactive red cells were found in all parts of the normal myocardium and in all parts of the ischemic myocardium distal to the point of ligation, again demonstrating the existence of functional anastomotic channels supplying the ischemic myocardium. Volume studies showed a significant diminution in the subendocardial side of the ischemic (about one third) as compared with the non-ischemic myocardium of the left ventricle.

That portion of the right ventricle, normally supplied by the ligated anterior descending artery showed no volume changes. This also indicates that the subpericardial side of the ischemic myocardium of the left ventricle is better nourished by the collaterals than the subendocardial side, and that the ischemic portion of the right ventricle is better nourished by collateral blood than a similar portion of the left ventricle.

The ratio of blood found in the ischemic myocardium to that found in the non-ischemic was just as great at thirty minutes as at one and a half minutes after ligation; also, the ratio was no greater after radioactive red cells had circulated for ten minutes as against twenty-five seconds, indicating that the collateral blood supply to the ischemic area is a continuous, actively circulating one, which supplies the entire ischemic myocardium.

3. In order to determine the sources of the collateral circulation following acute coronary occlusion in the living dog, fluorescein was injected into the femoral vein, and high-speed color moving picture studies were made of the heart. In normal hearts the fluorescein appeared in the major coronary arteries in five to seven seconds, and then spread very rapidly over the adjacent myocardium, with maximum filling within ten to sixteen seconds. In hearts with the anterior descending branch of the left coronary ligated, the first thing observed was a light yellow color in the circumflex branch of the left coronary, in the marginal artery, and in the anterior descending branch up to the point of the ligature, but none distal to the ligature. The fluorescein then spread over the surface of the myocardium, adjacent to the non-ligated vessels, and surrounded and gradually filled the ischemic area in from fifteen to thirty seconds. Section of the ischemic area showed less fluorescein in the subendocardial surface than on the subpericardial portion. That portion of the right ventricle adjacent to the anterior interventricular sulcus and to the right of the ligated artery showed fluorescein upon the first sweep of the dye over the heart.

It is concluded that the collateral blood entering the ischemic myocardium of the left ventricle is supplied largely, if not wholly, by the interarterial anastomoses between the adjacent coronary arteries and the terminal branches of the ligated artery.

Cyanosis of the ischemic myocardium following ligation of the anterior descending artery was also observed by means of motion pictures of the dog's heart with film sensitive to blue color. Even though the ischemic myocardium has an actively circulating blood supply, the presence of cyanosis indicates that the rate of flow of blood in the ischemic area is less than in the normal myocardium.

Sixteen illustrations, including 8 radioautographs and 1 color plate; 1 table. HENRY K. TAYLOR, M.D.
New York, N. Y.

THE DIGESTIVE SYSTEM

Radiographic Appearance of the Gastrointestinal Tract During the First Day of Life. Milton G. Wasch and Abraham Marck. J. Pediat. **32:** 479–489, May 1948.

Because of the difficulty of early recognition of intestinal obstruction in the newborn, the authors attempted to investigate the distribution of air in the intestinal tract of a normal infant during the first day of life. Studies were made on 50 infants at different hours. In no one infant was a complete series of studies made.

Means of identifying the various parts of the gastrointestinal tract are described. The air-filled antrum of the stomach lies just to the left of the twelfth dorsal and first lumbar vertebrae. It is elliptical in shape and its measurements average 4.5 cm. × 2 cm. by the eighth hour of life. It tends to be smaller prior to and after that time.

The proximal portion of the small bowel is seen within the first hour after birth. It is visualized as small, discontinuous, air-filled segments in the left half of the abdomen. Between the first and third hours, the remainder of the small bowel fills, and the segments of the large bowel appear.

The colon is identified mainly by its large caliber. After the third hour, areas of radiolucency of large caliber are visualized in the flanks and in the true pelvis.

These may lie transversely in the upper abdomen and represent the colon.

Three to eight hours after birth, a variable amount of air within the true pelvis is interpreted as being in the sigmoid and rectum and may be identified best by radiographs with the infant inverted.

After the eighth hour feeding, the air shifts into the large bowel from the small bowel.

Two cases are reported in which early diagnosis of obstruction might have proved life-saving.

Twelve roentgenograms; 1 table.

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital

Leiomyoma of the Esophagus and Cardia of the Stomach. Roger A. Kenworthy and C. Stuart Welch. Surgery **23:** 745–752, May 1948.

Leiomyoma of the esophagus is of unusual occurrence. Necropsy studies would indicate a higher incidence of gastric leiomyoma, though cases producing symptoms are relatively rare. Involvement of both the stomach and esophagus by a leiomyoma is still more uncommon. Only four such cases were found in a thorough search of the literature. In two of these the tumor was an incidental postmortem finding; in the others symptoms led to operation, at which the diagnosis was established. A fifth case is reported here.

The authors attempt to present some diagnostic criteria for esophageal leiomyoma. This is difficult, since all neoplasms of the esophagus have much the same clinical manifestations. As to roentgenologic findings, the important features differentiating benign extramucosal tumors from carcinomatous deformities are few, but careful observation may lead to a correct diagnosis. The presence of a bulky and mobile soft-tissue mass attached to the deformed esophageal area and more or less bulging into the mediastinum is characteristic of benign tumor and quite unlike the elongated fusiform soft-tissue density ensheathing a stenosing carcinomatous filling defect. Other evidences of a benign growth are dilatation of the wall at the level of and opposite the affected segment; absence of undermining margins, smooth margins of the fork-like appearance of the barium, variations in the shape and dimensions of the filling defect, absence of actual obstruction, the presence of a smooth variable mold effect, absence of mucosal erosion, preservation of normal folds in the immediate vicinity of the filling defect, and the observation of a barium ring or "ring sign." The final diagnosis, can be established only by esophagoscopy and biopsy.

The authors' patient was a 56-year-old housewife who complained of abdominal pain of three days duration. A filling defect within the lower esophagus and cardiac end of the stomach was observed on roentgenologic examination and a diagnosis of carcinoma was made. At operation a large mass was found in the lower end of the esophagus, extending into the stomach. This proved on microscopic study to be a leiomyoma. A lateral roentgenogram and the artist's drawing of the tumor are included.

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

Radiological Aspects of Peptic Ulcer. A. C. Singleton. Canadian M. A. J. **58**: 338–343, April 1948.

While gastric and duodenal ulcer are alike in their symptoms and complications, there is a difference in other implications of the two lesions. Demonstration of a gastric ulcer implies a differentiation between benign and malignant. With duodenal ulcer, on the other hand, the possibility of carcinoma is minimal and one is concerned chiefly with the stage of activity and questions of obstruction, perforation, and previous ulceration. The importance of a careful and thorough examination, including mucosal studies and spot filming, is stressed.

A number of criteria are suggested for differentiation of benign and malignant ulcers of the stomach: Benign gastric ulcer is practically always an addition to the normal contour, while malignant ulcer frequently appears as a crater in a lesion which is itself a subtraction from the general contour. The benign ulcer is a section of a cone or cylinder with its greatest width at its junction with the gastric lumen. It presents a smooth or finely granular base. Gross irregularity of outline or overhanging edges favor malignant ulcer. A narrow zone of inflammatory infiltration without evidence of palpable mass is common in benign ulcer. A wider zone of infiltration, with or without a palpable mass, suggests a malignant ulcer. The benign ulcer tends to show a mucosal pattern of bars radiating from the crater, while a carcinomatous ulcer usually obliterates the mucosal pattern in the immediate vicinity.

The size of the crater is not of practical value in differentiation, but the position in the stomach may be of some help. Some 90 per cent of benign gastric ulcers occur in an area along the lesser curvature from a point 2 cm. proximal to the pylorus to a point 2 cm. below the esophageal opening and within 3 cm. of the lesser curvature on the anterior and posterior walls. Those in the cardiac end are the most difficult to diagnose, primarily because of inaccessibility to palpation and compression filming. If one eliminates the obvious ulcerating carcinomas, the proportion of benign to malignant ulcers in the prepyloric area is four to one. On the greater curvature, however, the vast majority of ulcers will be shown to be malignant and should be so considered until proved otherwise.

Careful radiologic examination correlated with adequate clinical study will differentiate between most benign and malignant ulcers. When there is doubt, it is recommended that the patient be on complete bed rest and medical management for a period of three weeks to one month, and the lesion then be rechecked. On this regime, a benign ulcer will usually diminish to one half its size or less, while a malignant ulcer will change but little. Relief of symptoms is usually dramatic in benign ulcer treated in this way, while in malignant ulcer there is usually little symptomatic change.

The direct signs of duodenal ulcer are crater, scar or spasm, or any combination of these. With unobstructing duodenal ulcer, there is usually hypertonus, hyperperistalsis, and rapid emptying of the stomach. With long-standing obstructing duodenal ulcer, there is hypotonus, poor peristalsis, and slow emptying. Proof of activity is the demonstration of the crater. This is usually possible with careful fluoroscopic study, compression films, and serial films. The presence of constant spasm and deformity is suggestive but not conclusive. There may be small mucosal erosions accompanied by other signs of ulcer which cannot be shown by radiological examination.

Obstruction, perforation and hemorrhage are the most common complications of duodenal ulcer. A six-hour gastric residue in an ambulatory patient usually in-

dicates some obstruction. With severe obstruction, it may be impossible to differentiate between stenosing ulcer and obstructing annular carcinoma at the first examination. Re-examination after ten days of bed rest and daily gastric lavage will usually allow one to make the diagnosis.

With acute perforation, only scout films of the abdomen are made. It is preferable to use the erect or lateral recumbent position to show the presence of free gas. Chronic perforations are occasionally seen with walling off, so that the barium does not enter the general peritoneal cavity. These are usually posterior wall perforations of the first or second portions and may form a sinus tract or penetrate into adjacent viscera, notably the common bile duct, to form an internal biliary fistula.

In most cases of upper intestinal hemorrhage, the source will be found in the esophagus, stomach, or duodenum. Though the clinical story may suggest ulcer, repeated examinations may fail to reveal a crater. Whether hemorrhage in such cases is due to mucosal erosions too small for demonstration, or the technic is at fault, the author does not know. He believes, however, that it is wise to withold radiological study with barium until a week or ten days after bleeding has stopped. At that time, a more careful and complete examination can be made with better opportunity of finding the crater. Shorter intervals raise the possibility of producing further hemorrhage; longer ones, the possibility of the ulcer healing in the interim. Postoperative marginal gastrojejunal ulcer should be demonstrable by the same methods as gastric and duodenal ulcer. Only if the crater can be shown, can one be positive that an ulcer is present.

Eight roentgenograms.

BERNARD S. KALAVJIAN, M.D.
Detroit, Mich.

Prepyloric Spasm Simulating Gastric Malignancy. Allan L. Cohn and Rubin L. Gold. Gastroenterology **10:** 782–791, May 1948.

Eight cases are reported in which prepyloric spasm required differentiation from gastric cancer. The initial roentgen examination demonstrated various changes in the gastric antrum. Narrowing and constriction of the prepyloric region and, in some, partial pyloric obstruction were noted. Gastroscopic examinations, repeated roentgen studies after the administration of antispasmodics, and, in some patients, exploratory operations were performed before a correct diagnosis was made.

In 4 of the cases there were organic lesions to account for the prepyloric spasm: in 2, high lesser curvature benign ulcers, in 1 a duodenal ulcer, and in 1 a malignant ulcer high on the lesser curvature. In 2 patients there was no demonstrable lesion and psychic influences are suggested as the etiologic factor.

It is concluded that, when a malignant lesion cannot be excluded by all diagnostic aids, exploration is indicated.

Four roentgenograms. ALTON S. HANSEN, M.D.
Peoria, Ill.

Stenosis of the Duodenum Caused by Enteroperitonitis During Fetal Life. Maria Pellini and Noel Orlandi. Radiol. med. (Milan) **34:** 257–263, May 1948. (In Italian)

The authors report the case of an infant in which the radiologic examination performed at the age of five days disclosed a duodenal stenosis at the level of the third portion. This stenosis was thought by the radiologist to be of congenital origin, but at surgery and later at autopsy it was found to be due to a chronic inflammation of the duodenum and of the surrounding peritoneum, with constricting adhesive bands. Since the patient was only five days old when first examined, the authors conclude that the process had begun during intra-uterine life.

Two roentgenograms; 2 photographs.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Enteric Cyst of the Duodenum. Report of a Case and Review of the Literature. Stanley H. Lorber and Thomas E. Machella. Gastroenterology **10:** 892–899, May 1948.

Only 13 enteric cysts of the duodenum were found reported in the literature. [A fourteenth case was recently reported by Shallow, Wagner, and Manges (Surgery **21:** 532, 1947. Abst. in Radiology **50:** 265, 1948).]

The authors' case is that of a 17-year-old white boy who for six months had had severe attacks of colicky epigastric pain, usually occurring shortly after the evening dinner. Roentgen examination showed a probable tumor in the second portion of the duodenum. A second examination was done in which use was made of a double-lumened Miller-Abbott tube, one lumen of which communicated with a distally placed balloon. This balloon was placed in the third portion of the duodenum and inflated, and through the proximal lumen barium was introduced, resulting in sharp definition on the films of the mass in the duodenal wall. Surgical removal resulted in complete relief of symptoms.

In 10 of the 13 patients with duodenal cysts reported in the literature, symptoms developed in the first year of life. All except the 3 who died within a few days of birth had symptoms of partial or compete intestinal obstruction. Nine had a palpable tumor, 3 gross hemorrhage.

Three roentgenograms; 1 photomicrograph; 1 drawing; 2 tables, showing details of reported cases.

ALTON S. HANSEN, M.D.
Peoria, Ill.

Multiple Diverticula of Jejunum. Jas. Herbert Wilkerson and Robert Coffman. Am. J. Surg. **75:** 733–738, May 1948.

Diverticula of the jejunum are the rarest type of diverticula in the gastro-intestinal tract. They were first described by Cooper in 1844, and the authors state that 322 cases have been reported. Most of these diverticula were found either at autopsy, during abdominal operation, or by x-ray examination. They are much larger than the usual tiny diverticula seen in the colon. The majority are produced by herniation of the mucous membrane through the wall of the small bowel, at the site where the blood vessels perforate the muscular coat of the intestine. Some observers believe that they may be congenital in origin and others attribute them to a pulsion force acting from within a weak area in the bowel wall. Most jejunal diverticula are situated within the leaves of the mesentery or along the mesenteric attachment. Their mouths vary from 2 mm. to 5 cm. in diameter.

Jejunal diverticula may be unaccompanied by clinical symptoms or there may be vague pain or abdominal discomfort and flatulence. The most common complications are acute or chronic intestinal obstruction, inflammatory disturbances, hemorrhage, rupture of the diverticula, foreign bodies, and intradiverticular neoplasms.

The authors advise operation only when symptoms are present. They report one case of multiple jejunal diverticula with symptoms of chronic intestinal obstruction. The diagnosis was made during abdominal operation, having been missed in the preoperative x-ray examination. Following operation, the films were reviewed, and the diverticula were seen.

Five illustrations, including 3 roentgenograms.

JORGE DE LA FLOR, M.D.
University of Pennsylvania

X-Ray Examination of the Vermiform Appendix. A. J. Delario. Am. J. Digest. Dis. **15:** 151–161, May 1948.

The surgeon, as a rule, needs very little help from the roentgenologist in diagnosing acute or chronic appendicitis. The correct diagnosis, however, is not always made. In at least 15 per cent of cases with a diagnosis of acute appendicitis, and in a much higher percentage of subacute or chronic cases, a pathological appendix has not been found at operation. In many of these cases an x-ray examination of the gastro-intestinal tract before surgery would have established a correct diagnosis.

There are three main types of appendix: the fetal type, where the appendix is a continuation of the cecum; the infantile type, in which the appendix appears rather abruptly from a sacculated area between two muscle bands; the adult type, with the appendix close to the ileocecal junction. The position of the appendix depends also on the amount of rotation of the intestines during fetal life. During the fourth month of gestation the appendix leaves its position on the left side, ascends, then descends to the right lower quadrant. This arc may stop at any point in its course. During rotation the appendix may become attached to the parietal peritoneum, especially if the meso-appendix is short, and by absorption it may lie outside the peritoneum. In this case it usually lies behind the colon. Because the appendix is fixed in these cases, it is about five times as susceptible to inflammation, and the symptoms are not the usual ones associated with appendicitis. Nausea and vomiting may be present, but the localized pain is usually above the crest of the ilium. A retroperitoneal or retrocolic appendix may be suspected if the ileum can be seen projecting from the apex of the cecum, and the terminal ileum is not movable on palpation. The appendix, if visualized, will usually be seen extending upward on the lateral edge of the cecum.

The appendix may be displaced upward by a tumor in the pelvis; it can be displaced medially by an ectopic kidney, and it can be displaced downward by lesions of the gallbladder, liver, and kidney.

The average length of the appendix is 10 cm., though it may be as long as 25 cm. and as short as 0.5 cm. It tends to decrease in size with age. It is partially occluded in 50 per cent of persons over the age of sixty, and is completely converted into a fibrous cord in 4 per cent. Club-like persistent dilatation of the distal end, persistent irregularities, and kinking are usually signs of recent or old lesions.

Non-opaque fecaliths, concretions, and foreign bodies appear as constant translucent areas. Occasionally radiopaque concretions and foreign bodies such as shot and pins are seen. These eventually result in an acute appendicitis.

The author first takes a flat plate of the abdomen. This will allow a study of the kidney and gallbladder area. It will show the psoas muscle and may show a scoliosis of the spine secondary to an appendiceal abscess. If an acute appendicitis is suspected, a cautious barium enema study is done. If the condition is not acute, barium is given by mouth, and if the appendix is not visualized in the six-, twenty-four-, or forty-eight-hour film, a repeat examination is done. One to two teaspoonfuls of epsom salts are given two hours before giving barium. This liquefies the material and the appendix is more easily filled.

Disease of the appendix may be determined by its inability to fill, by deformity of the cecum, or by pain on palpation of the appendiceal area during fluoroscopy. A filled appendix may be painful on pressure, and may show a constant deformity, with opaque or non-opaque stones. An appendiceal abscess or tumors may be diagnosed by constant deformity of the cecum.

Twenty-nine roentgenograms; 1 drawing.

JOSEPH T. DANZER, M.D.
Oil City, Penna

Pancreatic Calculi. Donald Court and Norman M. Matheson. Gastroenterology **10:** 848–858, May 1948.

The presence of pancreatic calculi should be suspected and roentgen studies should be undertaken in patients who present one or more of the following: painful diabetes, steatorrhea, unexplained enlargement of the liver, recurrent attacks of severe upper abdominal pain without evidence of peptic ulcer or cholelithiasis, bilateral pulmonary inflammation starting in adult life, recurrent or persistent parotid swellings.

The calculi are radiopaque and readily demonstrable on plain films. These films should cover a wide area of the abdomen and chest. In one of the authors' cases stones were demonstrated as high as the upper margin of the tenth rib. Lateral views are of value for the demonstration of prevertebral calculi and for differentiation from concretions in the urinary conducting system. At time cholecystography and/or contrast urography may also be necessary for differentiation. Calcified lymph nodes, renal calcifications in tuberculosis or hyperparathyroidism, and calcifications in aneurysmal dilatations of the splenic artery must also be considered.

Two types of pancreatic lithiasis exist: multiple stones in the larger ducts and, of less common occurrence, extensive parenchymal calcification, or pancreatic calcinosis. Surgical removal of the calculi in cases of the first type is the treatment of choice.

The genesis of the stones is not understood.

Three roentgenograms; 5 drawings.

ALTON S. HANSEN, M.D.
Peoria, Ill.

Amebic Liver Abscess. Morris Zuckerbrod, Joseph Litwins, Francis T. Rogliano, and David Jellinger. Ann. Int. Med. **28:** 798–813, April 1948.

Three cases of amebic liver abscess seen in a Station Hospital demonstrate the need for considering this possibility in the differential diagnosis of obscure cases

of right upper quadrant pain, pleurisy with effusion, and subphrenic abscess.

While figures vary, liver abscess may be said to occur in perhaps 8 to 9 per cent of all cases of amebiasis with clinical symptoms. Usually the right lobe of the liver near the dome of the diaphragm is involved. Most commonly, the abscess is single, though multiple abscesses are not so rare as once supposed.

The relation of amebic liver abscess to intestinal amebiasis, dysentery and colitis is so irregular that the failure to find amebae in the stool or absence of an active colitis is of no value in excluding the disease. In only one of the three cases presented were amebae found in the stools, and then only in material obtained on proctoscopic examination. Not once was a routine stool examination positive.

Of the complications of amebic liver abscess, rupture into the pleura or lung is most common. While the occurrence of pulmonary involvement is usually manifested by the expectoration of a bloody or brownish sputum, the insidious onset of cough, chest pain, small amounts of white mucoid sputum, and presence of bubbling râles may antedate the frank lung abscess formation or hemoptysis by many weeks.

In the three cases presented, the clinical course was such that it was believed that rupture of the liver abscess into the lung had occurred in two cases, but in neither of these was there frank roentgen evidence of pulmonary parenchyma involvement, and in neither case were amebae demonstrated in the sputum.

The value of roentgen examination in the diagnosis of liver abscess is well known. Fluoroscopy is necessary to determine whether the lesion is above or below the diaphragm and whether it is located anteriorly or posteriorly. Radiographic examination in various positions before and after paracentesis, followed by injection of air, is probably the most important procedure in establishing the diagnosis and revealing the size of the abscess. Films taken in the anteroposterior, lateral, and decubitus positions show shifting of the fluid level and enable measurement of the cavity in three planes. Repeated examinations will demonstrate the effect of therapy. Improvement is indicated by a diminution in the size of the cavity.

Therapeutically a combination of emetine, diodoquin, and aspiration appears to yield the best results. Aspiration should not be done before the end of the first week of emetine administration unless there is a question of diagnosis or if rupture appears imminent. Open operation should be considered when (1) fever and leukocytosis persist and the secondary infection cannot be controlled by the sulfonamides or penicillin; (2) when involvement of other organs demands it.

Twelve roentgenograms.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Water Soluble Contrast Medium for the Precise Roentgenological Diagnosis of Cysts of the Common Bile Duct. Sven Roland Kjellberg. Acta radiol. **29:** 307–310, April 30, 1948.

The author reports a cyst of the common bile duct of a seven-year-old boy, the diagnosis being made by the injection of a water-soluble contrast medium and subsequently confirmed by surgery. No gallbladder shadow was obtained on repeated cholecystography. A flat film disclosed a large soft-tissue mass continuous with the liver. It had a sharply outlined border and produced downward displacement of the colon and small intestine.

The cyst was punctured with a fine needle and 20 c.c. of perabrodil were injected slowly. Right and left lateral decubitus films, and supine and prone films were made with a horizontal beam. A small gallbladder lateral to the cyst was demonstrated by retrograde filling from the cyst. The patient later died of a postoperative peritonitis from leakage around the sutures and the condition was carefully studied at autopsy.

Four roentgenograms. STANLEY H. MACHT, M.D.
Baltimore (Md.) City Hospitals

THE MUSCULOSKELETAL SYSTEM

Osteopetrosis. Osteopetrosis Generalisata, Marble Bones, Albers-Schönberg's Disease, Osteosclerosis Fragilitas Generalisata. H. A. Thomas Fairbank. J. Bone & Joint Surg. **30B:** 339–356, May 1948.

The condition described by Albers-Schönberg in 1904 and given the name of osteopetrosis by Karshner in 1926 represents a rare developmental error whose chief characteristic is an excessive density of most or all of the bones of the skeleton.

There is a definite familial tendency; the disease affects both sexes and has been found at all ages from fetal life to seventy-five years. The cause is unknown.

Clinically, the chief features, in addition to the abnormal bone density, are anemia and optic atrophy. The severity and course of the disease vary considerably. It may run a benign or malignant course. In a well marked case the formation of abnormally dense bone continues until growth ceases. There may, however, be intermissions, remissions, or complete cessation of the developmental error before that time.

The bones may be intensely hard like marble or soft like chalk. In some cases there is a tendency toward fracture.

The anemia results from a reduction in the blood-forming marrow in the sclerosed bones and may prove fatal. It does not always correspond to the severity of the bone condition. The serum calcium is usually normal but is occasionally raised. Phosphatase is either normal or slightly low.

The roentgenologic features of the disease depend on the varying degrees of abnormal density of the bones. Occasionally less dense areas may be seen in the sclerosed bone. As a rule, the metaphyses are more affected than the shafts of the long bones; they are commonly enlarged or clubbed, the enlargement ending abruptly at the junction with the diaphysis. The phalanges are usually less affected than the rest of the skeleton. They show a dense transverse band of varying width in the metaphysis close to the epiphyseal line.

The petrosed bone is marble gray on section. The shaft may be completely solid. The architecture is disordered and irregular. Osteoblasts may be normal or increased; osteoclasts may be normal or absent.

Occasionally limited distribution of the dense bone may give rise to difficulty in classification.

The author presents seven cases, each rather fully illustrated with roentgenograms. These are worth study because of the demonstration of bands of decreased and increased density in the various bones.

Twenty-nine roentgenograms; 2 photomicrographs.

JOHN R. HODGSON, M.D.
The Mayo Clinic

Osteoporosis Occurring During Potassium Thiocyanate Therapy for Hypertensive Disease. John J. Hinchey, Edgar A. Hines, Jr., and Ralph K. Ghormley. Am. J. M. Sc. **215:** 548–554, May 1948.

Observation of several cases of osteoporosis and arthralgia in patients who were receiving potassium thiocyanate for hypertension led to an investigation of 5,000 hypertensive patients at the Mayo Clinic. Among the 360 patients in this group who had received potassium thiocyanate, 7 showed unexplained osteoporosis. Since that time, 4 other cases have been observed, bringing the incidence to about 2 per cent of all those receiving this type of therapy. (Patients with involvement of spine or pelvis and those with any type of arthritic involvement were excluded.) On the other hand, no instance of unexplained osteoporosis was observed in more than 5,000 patients with hypertension who were not receiving potassium thiocyanate therapy.

The dosage of the drug ranged from 0.4 to 0.6 gm. daily and symptoms commenced in from three to six months after therapy was started. The only measure which brought relief was discontinuance of the treatment, after which improvement was evident in two to three months and complete in five to seven months. Adequate blood chemistry studies were available for most of the cases studied.

Evidence suggested a slight and prolonged interference with calcium metabolism as a possible mechanism for production of the syndrome. It would appear that adequate calcium intake should be assured for all patients undergoing this type of therapy and that its use may be contraindicated in cases of bone malacia and fractures.

Six roentgenograms; 2 tables.

GEORGE REGNIER, M.D.
University of Arkansas

New Concepts of Osteomyelitis in the Newborn Infant. Charles G. Hutter, Jr. J. Pediat. **32:** 522–529, May 1948.

Osteomyelitis in infancy usually occurs in the course of a septicemia. In most of the reported cases the disease has been held to run a fairly benign course but, in spite of intensive use of penicillin and sulfa derivatives, this has not been the author's experience during the years these drugs have been in common use. On the contrary, he has found osteomyelitis of the newborn infant to be among the most severe and serious infections encountered. Two cases with marked residual deformities due to bone destruction during the acute phase of the disease are reported.

Believing that a comparison of mortality rates before and after the penicillin and the sulfa derivatives became available for treatment might furnish a satisfactory explanation of the recent appearance of these severely disabling types of the disease, the author reviews briefly two groups of cases. (Only cases due to staphylococcic infection are considered, as cases due to *Streptococcus* seem to have disappeared as a result of the efficacy of the new drugs.) Among 12 cases seen between 1934 and 1943 there were 7 deaths (58 per cent). None of the 5 survivors suffered a stormy or prolonged clinical course and subsequent examinations showed no severe deformities or osteomyelitic residua. In a group of 6 cases seen after 1943, on the other hand, treated with large doses of penicillin and sulfadiazine, there were no deaths, but 2 patients showed severe bone damage and deformity and 2 others had residual deformity of one joint.

It is considered logical in view of these observations to postulate that the 2 patients in the second group who exhibited the most severe form of the infection and disabling deformities probably represent the group which, prior to the introduction of penicillin, succumbed, and to suggest that with an increased survival rate an increased number of severe systemic reactions and permanent bone changes may be expected.

The diagnosis of osteomyelitis in the newborn is frequently masked by the more general reactions to infection. Perhaps the most important diagnostic aids in the early stages are blood cultures and roentgenography. Periosteal elevation and areas of bone formation and destruction are usually not demonstrable on the film until after a week, but widening of the joint space may be seen early in the course of the infection and is a significant finding.

Ninety per cent of the author's cases showed involvement of a hip joint. The earliest roentgen finding in these was a lateral displacement of the femoral head from the acetabulum. This could be distinguished from congenital dislocation by preservation of the normal arch of the acetabulum and associated soft-tissue swelling. Later, periosteal elevation and bone destruction were demonstrable.

Six roentgenograms; 2 photographs.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Engelmann's Disease. Osteopathia Hyperostotica Sclerotisans Multiplex Infantilis. Report of a Case. H. R. Sear. Brit. J. Radiol. **21:** 236–241, May 1948.

Engelmann's disease is the rarest of the congenital bone dystrophies of the group which includes osteopetrosis, melorheostosis, osteopoecilia, and punctate epiphyseal dysplasia. Since Engelmann first described it (Fortschr. a. d. Geb. d. Röntgenstrahlen **39:** 1101, 1929) no other cases have been reported.

The author's patient was a boy of ten who had always been frail. At the age of three he began to have difficulty in walking. On examination, the child appeared fairly well nourished. He had occasional facial twitches. There were wasting of the leg muscles, mild pes cavus, slight knock knees. The patellar reflexes and ankle jerk on one side were absent. The spleen and liver were slightly enlarged.

Roentgenograms showed dense sclerosis of the long bones, mainly in the central parts of the shafts. The base of the skull was very dense and thickened.

Seven roentgenograms; 2 photographs; 1 drawing.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Skeletal Hemangio-Endothelioma. A Case Report. Emil D. W. Hauser and George A. Constant. J. Bone & Joint Surg. **30A:** 517–521, April 1948.

A 40-year-old white female sustained a pathological fracture of the right femur. A year later there was a large mass in the right trochanteric region, with very little change since the earlier examination. There had originally been some thought that the lesion was malignant but, in view of the patient's survival and the unchanged picture, this was considered unjustified. Survey of other bones showed no evidence of metastasis but in the neck of the left femur was a cystic

lesion similar to that on the right. X-ray therapy was without effect, as was subsequent implantation of radium needles in the tumor tissue. An attempt at biopsy of the lesion of the left femur resulted in profuse bleeding, but the material obtained led to the diagnosis of hemangio-endothelioma.

This patient has lived for nine years but both lesions have extended greatly, involving the soft tissue and the bony structure of the pelvis.

The authors call attention to the fact that any skeletal lesion which shows cystic change, trabeculation, and invasion of the soft parts should suggest possible hemangio-endothelioma. The condition must be differentiated from benign cyst, metastatic carcinoma, giant-cell tumor, osteosarcoma, chondrosarcoma, echinococcus disease, and hemangioma. Biopsy is the main basis of diagnosis. Irradiation therapy is not effective, and surgical removal of the lesion is recommended.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Eosinophilic Granuloma. Report of a Case with X-ray Evidence of Rapid Progression. William J. Baker, John D. Houghton, Egon Wissing, and Reeve H. Betts. New England J. Med. **238:** 626–629, April 29, 1948.

Eosinophilic granuloma usually occurs in young male patients, being extremely rare after the age of twenty-five. The lesions may be single or multiple and involve any bone except those of the hands and feet. X-ray films show rarefied punched-out areas which erode the cortex and through which pathological fracture may occur. New bone may develop about the fracture. There are no constitutional symptoms, although pain and tenderness may be present.

The authors' patient was a 39-year-old male who struck his chest one and one-half years previously. About a month and a half before examination, he experienced a severe pain in the right side of his chest, while lifting. Roentgenograms showed a small cystic lesion of the seventh rib posteriorly. A second examination, about four weeks later, showed increase in size of the lesion and after another month further progression of the destructive process was demonstrable. The possibilities considered were Ewing's tumor, osteogenic sarcoma, multiple myeloma, osteomyelitis, and eosinophilic granuloma. Resection of the rib was undertaken and the whole process found to be quite limited. The pathologist's report was eosinophilic granuloma.

Five roentgenograms; 1 photomicrograph.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Bone and Joint Pain in Leukemia Simulating Acute Rheumatic Fever and Subacute Bacterial Endocarditis. Mark Aisner and Thomas B. Hoxie. New England J. Med. **238:** 733–737, May 20, 1948.

This article reports in detail 4 cases of leukemia that closely simulated either acute rheumatic fever or subacute bacterial endocarditis. There are many similarities of symptomatology in leukemia and acute rheumatic fever. Either may show asthenia, palpitation, dyspnea, epistaxis, fever, bone and joint pain, abdominal pain, pallor, purpuric manifestations, lymphadenopathy, splenomegaly, anemia, tachycardia, accentuated heart sounds, and cardiac murmurs. Unless the blood picture is typically that of a leukemia, a differential diagnosis from this study may be impossible. The presence of a leukopenia associated with bone and joint pains should make one suspicious that these are not due to acute rheumatic fever. In the latter, one would expect to find a neutrophilic leukocytosis. When lymphocytosis occurs, especially in association with a leukopenia, the presumptive evidence is against rheumatic fever. An increase of the blood uric acid may occur in leukemia.

X-ray studies have shown bone changes in the leukemias, consisting of periosteal elevation, osteosclerosis, cortical stratification, rarefaction at the bone ends, spontaneous fractures, large tumor masses. The commonest finding is periosteal elevation, though none of the cases reported here showed this sign.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Peri-articular Calcifications in Lymphatic Leukemia. Alfredo de Maestri. Radiol. med. (Milan) **34:** 280–288 May 1948. (In Italian)

The author reports the cases of two children with lymphatic leukemia in whom a radiologic examination of the long bones disclosed multiple intra- and para-articular calcifications.

Ten roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

Anomalies of the Spine in Anomalies of Viscera and Constitution. A Radiological Contribution to the Physiology of Development of Man and to the Understanding of the Bearing of the Anomalies of the Spine on Pathology. Johan Torgersen. Acta radiol. **29:** 311–320, April 30, 1948.

The author points out the relative frequency of certain combinations of congenital anomalies by means of illustrative cases and a statistical review, and discusses the embryologic relationships involved. Two cases show the connection between development of the spine, coccyx, and kidneys. One patient with enuresis showed a double pelvis and ureter on the right side and a large defect of the sacral bone. The other patient had an imperforate anus in childhood, a single kidney, a peculiar, tail-like sacral bone, a defect of the coccygeal bone, and six lumbar vertebrae, of which two were fused.

Seven cases demonstrate the combination of anomalies of the spine and visceral inversion. These cases, in all of which there was complete visceral inversion, demonstrated such spinal defects as hypoplasia of a lumbar vertebra, severe scoliosis, six lumbar vertebrae, or a hemivertebra.

It is concluded that an apparently insignificant morphologic skeletal detail may offer a lead to important related anomalies. The observations demonstrate the advantage of radiography in the study of variations and anomalies in man and the importance of knowledge in certain fields of biology in the interpretation of roentgen pictures.

Ten roentgenograms. ROBERT LARNER, M.D.
Baltimore (Md.) City Hospitals

Compression of the Spinal Cord Due to Direct Extension from a Tuberculous Pulmonary Abscess. John R. Norcross. J. Bone & Joint Surg. **30A:** 492–495, April 1948.

Direct extension of a tuberculous process to the spinal canal has been rarely reported in the literature. The author presents two cases.

The first patient was a 30-year-old white male, who in July 1943 was found to have tuberculosis of the right lung. In November of the same year, neurologic signs and symptoms began to appear and two weeks later complete spastic paralysis of the lower extremities was present. A roentgen examination showed destruction of a portion of the third and fourth ribs on the right posteriorly and of the right third and fourth thoracic pedicles, but there was no evidence of true Pott's disease. At autopsy, three months later, a cavity was found at the base of the upper right lobe with extension posteriorly through both layers of the pleura and a sinus tract along the third and fourth ribs, destroying portions of these ribs and the third and fourth pedicles. The process extended through the intervertebral foramina into the spinal canal, producing compression of the cord.

The second patient was a boy of 12 years, first seen in June 1944 with pulmonary tuberculosis. A cold abscess appeared shortly thereafter, in the back just to the right of the midline in the upper thoracic region. This was found to be tuberculous. About two years later, paraplegia developed in the lower extremities, and after three months the patient died. At autopsy, the left lung showed a caseating process at the apex with a sinus extending to the back, involving the spinous processes of the third, fourth, and fifth thoracic vertebrae, and extending through the intervertebral foramina into the canal, compressing the cord at that level.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Paraplegia in Cervical Spine Injuries. Roland Barnes. J. Bone & Joint Surg. **30B:** 234–244, May 1948.

One of the most puzzling features of injuries of the cervical spine is the lack of correlation between the degree of vertebral displacement and the severity of the associated spinal cord lesion. There are cases with no roentgen evidence of bone injury in which the cord is irretrievably damaged, while in others with gross dislocation there may be no paraplegia.

Cervical spine injuries may be divided into flexion injuries and hyperextension injuries. The author's series of 22 cases in which paraplegia was present included 15 flexion injuries, all in patients under fifty years of age. These injuries are of three types: anterior dislocation, crush fracture of a vertebral body, and acute retropulsion of an intervertebral disk.

In cervical dislocation, the injury to the cord is due to pressure on its dorsal surface by the dislocated neural arches, often with coincident compression of the ventral surface by retropulsed disk material. Skeletal traction with the skull caliper is the treatment of choice in these cases.

Acute retropulsion of a disk is due to acute flexion of the head on the trunk. There were 3 cases of this type in the present series, and in none of these was there any roentgen evidence of bone injury, though in all narrowing of one intervertebral disk was demonstrable. Treatment is by skull traction or laminectomy, depending on the extent and progress of the paraplegia.

Four patients had crush fracture of a cervical vertebra. Two died and two survived. The progress of one case suggests that the cord injury associated with crush fractures in this region is due to compression of the ventral surface of the cord by retropulsed disk material.

The hyperextension injuries included one case of posterior dislocation and six cases of injury to an arthritic spine. All of the latter were in persons beyond the age of fifty-seven years. Elderly patients are predisposed to hyperextension injury because of the tendency to kyphosis in later years, with a compensating cervical lordosis. This deformity is relatively fixed and the risk of injury by hyperextension violence is greater because of the arthritic changes that are usually present. The author feels that there is no satisfactory explanation of the spinal cord injury. He considered two possibilities: (1) that it may be caused by "spinal concussion" as a result of minor displacement of a vertebral body, or (2) that it may be due to traction injury at the moment of extreme hyperextension. Experiments with markers on the spinal cord and simulated hyperextension injuries in cadavers failed, however, to support the theory that traction injury was responsible. Hyperextension injuries are treated by placing the patient in slight flexion by means of a pillow.

Eighteen illustrations, including 12 roentgenograms; 4 tables. JOHN R. HODGSON, M.D.
The Mayo Clinic

Paraplegia in Hyperextension Cervical Injuries with Normal Radiographic Appearances. Alexander R. Taylor and William Blackwood. J. Bone & Joint Surg. **30B:** 245–248, May 1948.

Damage to the cervical portion of the spinal cord without radiographic evidence of injury has been explained by the development of either an acute massive disk prolapse or a spontaneously reduced hyperflexion dislocation. The authors found neither of these explanations satisfactory, and suggest that the usual mechanism of cord injury is damage following forced hyperextension.

A case is presented in which autopsy revealed rupture of the anterior longitudinal ligament of the cervical spine between the sixth and seventh cervical vertebrae. The intervertebral disk was detached from the lower surface of the sixth cervical vertebra. The upper segment of the cervical column could be displaced backwards on the lower segment (and replaced) with ease, and at this point there was a sharply localized contusion of the spinal cord. It is believed that the contusion damage occurred at the time of injury, a headlong fall, that almost immediately the vertebral dislocation was reduced, and that thus the radiographic appearance was entirely normal.

The authors present a good argument for their conclusions regarding the mechanism of paraplegia without roentgen evidence of injury and, although they have only two cases, their explanation of the course of events, based on these, is both reasonable and logical.

It is emphasized that the value of recognition of hyperextension injuries lies in its bearing on treatment. If the hypothesis offered is true, then hyperextension in this type of injury is to be avoided, since it will only exaggerate the already existing cord damage.

Three photographs. JOHN R. HODGSON, M.D.
The Mayo Clinic

Discrepancies in Myelography. Statistical Survey of 200 Operative Cases Undergoing Pantopaque Myelography. William Beecher Scoville, William Henry Moretz, and Walter Douglas Hankins. Surg., Gynec. & Obst. **86:** 559–564, May 1948.

The authors made a survey of 200 operative cases in which pantopaque myelography was done. It was their

collective impression that myelography yields equivocal findings in at least 75 per cent of the cases. They point out that, while many other statistical surveys give an over-all accuracy of 92 to 93 per cent for contrast myelography regardless of the media used, these figures are erroneous, since they are based on positive myelography only, ignoring those cases with "normal" findings in which, nevertheless, a ruptured disk is found at operation.

The causes of error include (1) double disks, which occur in 12 to 14 per cent; (2) a high cul de sac; (3) a giant canal; (4) a congenitally narrow dural sac; (5) postoperative defects and adhesions; (6) the so-called subclinical protrusions or "hidden disks" of Dandy, consisting of a torn annulus with fragmentation and degeneration of the nucleus pulposus, and occasionally the cartilaginous plate, but without actual protrusion.

In the present survey, all myelograms were reviewed jointly by the roentgenologist and neurosurgeon without knowledge of the clinical or operative findings. Errors in diagnosis were divided into major and minor. Major errors constituted those in which the myelographic diagnosis was in direct contradiction to the operative findings, *i.e.*, a myelogram incorrectly diagnosed as normal or as abnormal. Minor errors included (*a*) errors in localization either by interspace or lateralization; (*b*) errors in differentiation between single and double disks; (*c*) errors of technic. The results of the survey were as follows:

(1) Four cases of lumbar spinal tumors were excluded from the statistics.

(2) Ruptured disks were found in 173, or 88 per cent, of the remaining 196 patients operated upon.

(3) Over-all errors in myelographic diagnosis occurred in 65 out of 196 cases, or 33 per cent.

(4) Major errors occurred in 32, or 17 per cent, of 190 cases (omitting 6 cases of technical error in 196 cases). These errors consisted of 25 (13 per cent) false negatives and 7 (4 per cent) false positives. In all but one of the false negatives, "disks" were found in the lumbosacral interspace at operation.

(5) Minor errors occurred in 33, or 17 per cent, of 196 cases. They included 6 (3 per cent) errors in technic and 27 (14 per cent) errors in localization.

From a detailed analysis of their survey, the authors state that the largest percentage of error occurs in those myelograms incorrectly diagnosed as normal. The second largest percentage of error occurs in the false localization of single disks. These two groups together account for 50 per cent of all myelographic errors.

The conclusions are as follows:

(1) Clinical evidence of a ruptured disk is more important than is myelographic evidence.

(2) A positive myelogram is more important than a negative myelogram. A negative or normal myelogram in the face of clinical evidence of a ruptured disk will be wrong three out of four times.

(3) Myelography fails to rule out the presence of a laterally placed lumbosacral "disk."

(4) Root sheath asymmetry is an important yet equivocal myelographic sign, which may or may not indicate the presence of a ruptured disk; it is of little value without confirmatory clincal evidence.

(5) Myelographic double defects are more common than are actual double "disk" ruptures or herniations.

(6) When myelography is used as the sole diagnostic criterion, the over-all error is in the neighborhood of 25 to 35 per cent in contrast to the 6 or 8 per cent cited in the literature.

Fifty-one roentgenograms.

MARC K. P. SIU, M.D.
University of Pennsylvania

Widening of the Root Defect in Lumbar Myelogram by Abrodil. Rasmus Stenström. Acta radiol. **29:** 303–306, April 30, 1948.

The author centers his article around a plea to the surgeons to observe carefully and record the condition on the nerve roots at operation for herniated disks. He examined 158 myelograms obtained with abrodil and found widening of the root defect in 42 cases. Operation was performed in 31 of these 42 cases, and so-called root swelling was mentioned in 11, that is, in one-third. According to the writer, this rather low figure probably depends partly upon insufficient attention on the part of the surgeon to the condition of the nerve root. In order to determine whether or not the widening of the root defect depends only on flattening or on actual swelling of the nerve root, continued cooperation between the operator and the radiologist will be necessary.

A set of 4 myelograms illustrates the points made by the author.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospitals

Salmonella Osteomyelitis of the Spine Associated with Abdominal Aortic Aneurysm. Report of a Case. Klaus R. Dehlinger. New England J. Med. **238:** 728–732, May 20, 1948.

A 69-year-old male was admitted to the hospital complaining of headache, nausea and vomiting, and loose stools. He had a left inguinal hernia. His temperature was 101.2° F. and pulse 104. The blood serology was negative. A roentgenogram showed calcification of the abdominal aorta. Agglutination tests for *Salmonella* organisms were positive.

About two months later the patient was readmitted for repair of the hernia but the persistent temperature elevation delayed operation. *Salmonella* organisms were obtained on blood culture and sulfadiazine and penicillin were without apparent effect. Chills and high fever developed and the patient complained of pain in the back. X-ray examination showed a normal appearing spine and calcification of the aorta. Another film taken six or seven weeks later showed a paravertebral mass displacing the aorta anteriorly and decalcification of the anterior bodies of the second and third lumbar vertebrae.

The patient died and at autopsy an abdominal aneurysm was found. Adjacent to the aneurysm was extensive hemorrhage into both psoas muscles. Interconnecting abscesses filled with foul-smelling pus lay directly posterior to the aneurysmal sac. The inferior vena cava had been invaded by the abscess. The anterior portions of the second and the third lumbar bodies were necrotic and bathed in pus. *Salmonella* organisms were cultured from the abscess.

In the discussion of this case, the rarity of *Salmonella* osteomyelitis of the spine is mentioned. No report of the condition could be found in American medical literature. A combination of aneurysm of the abdominal aorta and the osteomyelitis must be still more rare. No evidence of syphilis was found and it was therefore thought the aneurysm was either mycotic or

arteriosclerotic, more probably the latter. The erosion of the anterior vertebral bodies is rather characteristic of aneurysm, more so than of osteomyelitis.

Six illustrations, including 4 roentgenograms.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Pott's Disease of the Spine with Rupture of the Aorta. E. W. Somerville and J. Wishart. J. Bone & Joint Surg. **30B:** 327–332, May 1948.

Two cases of disease of the spine are presented. One case was a proved tuberculosis of the spine; in the other there was some doubt as to the etiology.

The authors suggest that in the first case tuberculosis of the tenth and eleventh dorsal vertebrae was of metastatic origin, resulting from dissemination of the disease after an excision of tuberculous glands in the neck. The patient also had a tuberculous abscess in the mediastinum, demonstrated roentgenographically, which became secondarily infected with *Streptococcus viridans* and subsequently ruptured into the esophagus and possibly the mediastinum. Infection of the eighth dorsal vertebra was due to direct extension from this abscess. The proximal end of the eighth rib subsequently became eroded through the neck. When the erosion was complete, the rib sprang forward, puncturing both the esophagus and the aorta, thus causing the patient's death.

The second case was diagnosed roentgenographically as tuberculosis of the spine, but the patient also had syphilis and the question of gumma had to be considered. Death occurred from rupture of a large aortic aneurysm. Unfortunately the specimen was lost in a fire and the authors can only speculate regarding the relationship of the bony disease of the spine and the aortic aneurysm.

Eight roentgenograms; 2 photographs.

JOHN R. HODGSON, M.D.
The Mayo Clinic

Roentgendiagnostic Points of View on Spinal Tumours in Children. Olle Olsson. Acta radiol **29:** 279–293, April 30, 1948.

After an introductory section on the types of spinal tumor occurring in children, the author reports two cases and on the basis of these discusses certain general and special conditions from the point of view of the roentgen examination. In both of the reported cases the thoracic spine was involved; in one the tumor was extradural and in the other intramedullary. In both instances the earlier diagnosis was erroneous, though roentgen examination could have solved the problem immediately in one, and after slight delay, while clinical signs were still indeterminate, in the other.

In general, the changes in the simple scout roentgenogram of the vertebral column are due to increased pressure within the spinal canal. They consist of erosion of one or both pedicles at the level of the tumor, rarefaction of the laminae, erosion of the bodies of the vertebrae, and widening of the intervertebral foramen. Besides the changes directly related to increased pressure, there occurs a thoracic kyphosis. This has usually been attributed to changes in the "carrying part" of the spine, *i.e.*, the line of vertebral bodies with the intervertebral disks. The author believes that there are good reasons to assume that the cause is to be found also, or perhaps solely, in a change in the "staying part" of the spine, *i.e.*, the groove formed by the arches and ligaments. Thus an extradural cyst, by pressure on the walls of the spinal canal, causes a complete atrophy of the posterior longitudinal ligament. The arches atrophy markedly both in breadth and height, and the ligamenta flava are probably also involved. This deficient support leads to an increase in pressure on the vertebral bodies, which in childhood are still in a stage of development and sensitive to reshaping.

Nine roentgenograms.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospitals

Solitary Myeloma of Mandible. Richard Spitzer and L. Woodhouse Price. Brit. M. J. **1:** 1027–1028, May 29, 1948.

A single case report of a solitary myeloma of the mandible is presented in which the diagnosis was made after surgical exposure of a lesion thought to be osteomyelitis. Pain had persisted following a tooth extraction and films showed an area of destruction. There is nothing specific about the appearance in the reproduction and the only films made were dental ones.

Survey films showed no other skeletal lesions but the follow-up time is not stated, so that it is probably too soon to call this a true solitary myeloma.

Two roentgenograms (dental); 1 photomicrograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Congenital Absence of the Humeral Head. Report of Two Cases. A. T. Andreasen. J. Bone & Joint Surg. **30B:** 333–337, May 1948.

The author adds two cases of congenital absence of the humeral head to the six previously reported. The deformity may be unilateral or bilateral and is associated with relatively slight disability. The ball-and-cup arrangement of the shoulder is reversed or replaced by a saddle-shaped articulation.

The defect probably occurs at an early stage of embryonic life and is due to failure of the capital epiphysis to form. At a very early stage, when the primitive joint has just begun to form, an accident occurs which alters the process of separation in the mesenchyme to form the articular ends. If the humeral defect is minimal, the glenoid is well formed; if the humeral defect is great, the glenoid is a mere rudiment.

Three roentgenograms; 2 photographs; 7 drawings.

JOHN R. HODGSON, M.D.
The Mayo Clinic

Fatigue Fractures of the Fibula. H. Jackson Burrows. J. Bone & Joint Surg. **30B:** 266–279, May 1948.

Fatigue fractures of bone are spontaneous fractures of seemingly normal bone that appear to result from a summation of stresses which singly are insufficient to produce fracture. The fibula as a site for fatigue fracture ranks in frequency after the metatarsus and tibia, and perhaps the femur.

The author has reviewed the literature and presents in table form all the previously published cases of fatigue fracture of the fibula, to which he adds 5 cases of his own.

Fatigue fractures of the fibula may be divided into two groups: (1) fractures in young male runners and skaters and (2) fractures in women of middle age or over who are much on their feet. The fracture was in the lower third of the fibula, 1 1/2 inches above the lateral

malleolus in the 4 women in the author's series and somewhat higher in the man. A similar distinction appears in the cases found in the literature.

The symptoms and signs are pain, stiffness, localized tenderness, localized swelling, some edema with occasionally slight redness, and increased local cutaneous temperature, often without limitation of ankle and tarsal movements.

During the first fifteen days no radiographic change may be demonstrable, though the fracture line may appear at the end of a week; sometimes it is not discernible until the end of the third week. It becomes organized at twelve to sixteen weeks. The plane of fracture is almost horizontal.

Fractures of the upper third of the fibula are reported in frequent association with jumping, as in artillery men jumping on and off the limber for long periods of time. As the metatarsal fracture is the typical "march fracture," the low fibular fracture is perhaps a "running fracture," and the high fibular fracture appears to be typically a "jump fracture." It is a speculative possibility that military and parachutist fractures of the upper third of the fibula indicate the link between the true fatigue fractures (as exemplified by march fractures with minimal trauma often repeated) and purely traumatic fractures (with adequate trauma applied once only).

Sixteen roentgenograms; 1 drawing; 2 tables.

JOHN R. HODGSON, M.D.
The Mayo Clinic

Periostitis of the Os Calcis. An Osteo-Periosteal Manifestation of Rheumatoid Arthritis. Hsien-Chi Fang. Chinese M. J. **66:** 57–65, February 1948.

A study was made of 68 cases of periostitis of the os calcis, a common disease of young Chinese males. Although gonorrhea has been considered a major offender in the production of calcaneal spur, that disease was encountered in only 8 cases in the present series. Eighty-one per cent of the patients were under thirty years of age when first seen, and of these 53 per cent had noticed the onset of symptoms before the age of twenty and 88 per cent before the age of thirty years. Seventy-three per cent of the patients suffering from periostitis of the os calcis also presented clinical signs of rheumatoid arthritis, suggesting that they might be one and the same disease.

In 63 of the 68 cases, the roentgen appearance of the os calcis and its surrounding structures was strikingly similar. In 1 of the other 5 cases the exostosis was due to a pyogenic infection, and in the remaining 4 the exostoses were the result of ossification of the tendo achillis and plantar fascia following osteoarthritic changes in elderly individuals.

At a casual glance, the roentgen appearance of advanced periostitis of the os calcis may appear to differ from that observed in rheumatoid arthritis. The os calcis is sclerotic instead of osteoporotic. There is abundant irregular ossification at the periphery, suggesting osteoarthritis. Careful follow-up of the patients indicates that the underlying pathologic process is the same.

The earliest change, as in rheumatoid arthritis, is in the soft tissues and is represented by a swelling either in the region of the insertion of the tendo achillis or the region of the inferior medial calcaneal tuberosity, or both. No osseous change, beyond slight general osteoporosis, can be detected roentgenologically at this stage. As time goes on, the swelling persists and the osteoporosis becomes more noticeable, not only in the os calcis but also in the other bones of the foot. There then appears the suggestion of a destructive process at either the inferior or the posterior surface of the bone. Simultaneously, proliferative ossification makes its appearance both within the substance of the os calcis and along its margin. A race between the two processes seems to ensue, in which eventually the proliferative process outstrips the destructive one. The normal osseous structure is replaced by sclerotic bone producing a ground-glass appearance in the roentgenogram. The new bone always looks irregular and fuzzy as a result of repeated destruction and reformation. Finally the os calcis becomes deformed, with a flattened or bulging bottom and a sharp projecting posterior margin.

Both Marie-Strümpell's disease and periostitis of the os calcis show a predilection for males, and the tendency to excessive new bone formation is strikingly similar in the two conditions. This is explained on the basis of the anatomical and functional similarity of the bones involved. Three patients in the present series had both diseases.

Nine roentgenograms; 7 photomicrographs.

GYNECOLOGY AND OBSTETRICS

Radiologic Study of Uterine Evacuation. Jean Dalsace. J. de radiol. et d'électrol. **29:** 107–115, 1948. (In French)

The author states that although hysterosalpingography has been practised for over twenty years, this method of diagnosis has not been employed to full advantage. He obtains serial roentgenograms following instillation of lipiodol. If only one roentgenogram is made, a lesion may be obscured due to overfilling of the uterine cavity by the opaque medium. Such a lesion may become apparent on later films, when the uterus has partially emptied.

If serial roentgenograms are employed, intra-uterine lesions may be diagnosed with a great degree of accuracy. The author believes that examination of the genital tract has too often been limited to the study of sterility. Aknin, a pupil of the author, reported 131 cases of metrorrhagia studied by this method (Diagnostic des métrorragies por l'hystéro-salpingographie. Paris, Louis Arnette, 1937). In this series, which included both benign and malignant uterine tumors, some going back to 1927, a correct diagnosis was obtained in 97 cases, further confirmation not having been necessary before undertaking treatment. Curettage was directed to suspicious areas in 31 cases. Lesions were not demonstrated in 2 cases and 1 case represented an error in diagnosis.

Sixty roentgenograms; 1 drawing.

RODERICK L. TONDREAU, M.D.
Mayo Foundation

Chinese Maternal and Fetal Measurements. David D. Kulcsar. Chinese M. J. **65:** 397–428, November-December 1947.

The author presents averages on 1,442 maternal and 600 fetal measurements compiled from hospitals in Kweilin, Kwangsi (South China). The study is divided into three parts. The first part consists of a critical review of previous publications, definition of "standard" and "limit of normal," organization of

study, equipment, source of material, selection of data, nativity, and method of presentation. The second part presents tables of maternal measurements. Averages from Kweilin and from previous publications are separately tabulated. Averages for North, West, Central, and South China are also shown separately. The third part presents fetal measurements tabulated separately for Kweilin, for previous publications, and for different geographical regions.

The average Chinese measurements are: interspinous 23.17 cm., intercrista 25.49 cm., intertrochanteric 28.70 cm., external conjugate 18.65 cm., bi-ischial 9.30 cm., sacropubic 10.77 cm., diagonal conjugate 11.50 cm.

The average Chinese fetal measurements are: weight 3,090 grams, height 50.17 cm., biparietal 8.93 cm., bitemporal 7.72 cm., suboccipito-bregmatic 9.55 cm., occipito-frontal 11.19 cm., occipito-mental 12.85 cm., suboccipito-bregmatic circumference 31.83 cm., shoulder circumference 34.11 cm., and chest circumference 32.79 cm.

Thirty tables; 7 charts.

Opisthotonos Fetalis in Breech Presentation. Report of a Case with Bilateral Congenital Posterior Dislocation of the Tibiae. George F. Melody. California Med. **68:** 378–380, May 1948.

It has been suggested that some cases of breech presentation may be the result of fetal conditions which inhibit free movement *in utero* and thus prevent spontaneous cephalic version, which usually occurs in the later months of pregnancy. The case recorded here lends support to this theory.

The prognosis in breech delivery is dependent to some extent on fetal flexion. Spontaneous delivery or delivery with minimal assistance may be expected if the breech is well flexed, whereas dystocia is to be anticipated if the fetus is in extension. This is best determined roentgenographically.

In the author's case roentgenograms taken two weeks from term showed the fetus to be in an attitude of opisthotonus, with the head arched against the back, and the anterior arm extended toward the pelvic inlet. A subsequent film, four days later, showed spontaneous correction of the extreme hyperextension, which was replaced by an attitude of flexion, permitting successful pelvic delivery. The child, a viable male, showed multiple orthopedic abnormalities, including posterior dislocation of both tibias and absence of the epiphyses for the lower ends of the femurs and upper ends of the tibias. Such deformities would readily preclude the freedom of motion *in utero* which usually brings about spontaneous version.

The advisability of careful x-ray study prior to term in cases of breech presentation is emphasized.

Three roentgenograms; 1 photograph.

MAURICE D. SACHS, M.D.
Cleveland, Ohio

THE GENITO-URINARY SYSTEM

Massive Hydronephrosis. Howard A. Hoffman. J. Urol. **59:** 784–794, May 1948.

The author reviewed 299 cases of hydronephrosis which were admitted to Massachusetts General Hospital from 1941 to 1946 inclusive. Over this six-year period, 10 cases of massive hydronephrosis were found, an incidence of approximately 3 per cent of the total. Massive hydronephrosis was arbitrarily defined as a kidney containing 1,000 c.c. or more of fluid.

The analysis of these cases and their management are presented. They were frequently asymptomatic and consequently not considered in differential diagnosis of abdominal masses, and often went unrecognized until some incidental matter suggested the need for urologic study. Some pitfalls and aids in the diagnosis are discussed. In the present series, except for one case with a ureteral calculus, intravenous pyelography failed to suggest the diagnosis. In 6 cases it revealed only a non-functioning kidney, and in another it showed a large mass. (In 2 cases it was not done.) Retrograde pyelography, on the other hand, led to the diagnosis in 9 of the 10 cases. In the tenth it was thought to show a large solitary cyst.

The author states that one reason for the importance of this disorder is that massive hydronephrotic sacs may rupture. Many such cases have been subjected to laparotomy because the patient was admitted in shock erroneously thought to be due to an intra-abdominal accident. When this occurred, the mortality was high (30 per cent).

In view of the more frequent occurrence of this disorder than is generally appreciated, a plea is made for the more widespread consideration of massive hydronephrosis in the differential diagnosis of abdominal masses with or without urologic symptoms.

Eleven roentgenograms; 2 tables.

R. C. RIPPLE, M.D.
University of Pennsylvania

Renal Rickets and Polycystic Disease of the Kidney. Herman L. Kretschmer. J. Urol. **59:** 773-783, May 1948.

The author presents an interesting case of renal rickets which developed on the basis of polycystic disease of the kidneys. The patient was a male infant and was followed from the age of five months until death at the age of four years. The child was retarded and dwarfed, with the development of marked rachitic bone changes in spite of the fact that he received cod-liver oil, tomato juice, and cereal in adequate amounts from the age of three weeks. A limited postmortem examination revealed bilateral advanced polycystic disease of the kidneys. In this case the primary disease was in the kidneys, the rachitic changes appearing secondarily.

A discussion follows of the various theories proposed to explain the chemical and physiological changes involved in the production of renal rickets.

The renal theory hypothesizes that the damaged kidney is unable to excrete phosphorus, the latter being accumulated in the blood and excreted in increased amounts through the intestinal mucosa, thereby interfering with the absorption of calcium, through the formation of insoluble calcium salts in the intestine.

The parathyroid theory is in dispute. Some writers believe that the bone changes in renal rickets are due to primary hypersecretion of parathormone. Others believe that primary hyperparathyroidism causes the renal damage by metastatic calcification and fibrosis. However, gross parathyroid hyperplasia is not a common complication of renal disease. When it occurs, it may be the result of stimulation by a long-standing low serum calcium, the latter a product of phosphorus retention due to renal disease. The resulting mobiliza-

tion of calcium from the bones aggravates the existing bony changes and can cause metastatic calcification and even further damage to the kidney. The parathyroids, therefore, probably play a part in this clinical syndrome, but the exact mechanism is difficult to evaluate.

The pituitary-diencephalon theory has been advanced by some workers who theorize that pituitary dysfunction could cause the dwarfism and retardation and, in addition, that a lesion involving the adjacent diencephalic autonomic center could produce urinary tract dilatation and stasis, thereby setting the stage for kidney disease and subsequent imbalance of the calcium and phosphorus metabolism.

This syndrome has also been explained on the basis of chronic acidosis resulting directly from renal insufficiency. Some workers claim that chronic acidosis alone can lead to osseous lesions. Others feel that acidosis, and not hyperphosphatemia, stimulates the parathyroids, thereby producing the osseous lesions.

In summary, the various possible signs and symptoms of renal rickets are enumerated.

Four roentgenograms; 3 tables.

D. B. NAGLE, M.D.
University of Pennsylvania

THE BLOOD VESSELS

Cerebral Arteriography. Sidney W. Gross. S. Clin. North America **28:** 405-411, April 1948.

Three cases are presented illustrating the usefulness of cerebral arteriography. One patient had a saccular aneurysm with subarachnoid hemorrhage, and cerebral arteriography was an aid in reaching a decision concerning ligation of the internal carotid. The second patient had a vascular malformation, resulting in hemiplegia and ultimately in a left homonymous hemianopsia. In this case, also, ligation of the carotid artery resulted in gross benefit. The third case appeared clinically to be a cerebral arteriosclerosis, with a considerable amount of deterioration, aphasia, and weakness on the right side. Pneumoencephalography failed to visualize the ventricles, whereupon an arteriogram was obtained. This showed displacement of the sylvian vessels by a mass which proved to be an encapsulated meningioma in the sylvian fissure. Removal of the tumor was followed by almost complete recovery.

The author points out that cerebral arteriography is coming into more general use as its indications are more clearly defined. He believes that, aside from permitting differentiation between aneurysm and tumor, it also provides valuable information regarding the probable histologic nature of the intracranial mass. He regards cerebral arteriography with 35 per cent diodrast as much safer than ventriculography in the poor-risk patient.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Venography in the Normal and Pathological Leg. G. H. Raymond, G. T. Adams, and J. R. McCorriston. Canad. M. A. J. **58:** 441-444, May 1948.

The authors' study covers 113 venograms in 100 patients. Their aims were (1) to develop a technic, (2) to identify and interpret normal structures, and (3) to demonstrate and identify pathological changes.

The usual "bone technic" exposure is used. In the *low injection* 20 c.c. of 35 per cent diodrast is injected into the dorsal vein of the foot or the distal end of the long saphenous vein at the medial malleolus. Usually no skin incision is required. The diodrast is injected over a period of sixty seconds with a tourniquet on the leg 3 or 4 inches above the ankle. This is kept tight enough to occlude the superficial venous flow and force the diodrast to the deep system. The film is exposed at the end of the injection. In the *high* injection, for demonstrating the upper femoral and iliac regions, the diodrast is introduced into the long saphenous vein just proximal to the knee joint. This requires a large bore needle and injection is made over a period of five or six seconds, at the end of which the exposure is made. No tourniquet is used.

The authors found that, contrary to general belief, the deep circulation of the lower extremity is fairly accurately duplicated in normal subjects. They warn of variations of filling of the anterior and posterior tibial veins and the deep femoral vein. Close clinical correlation is strongly advised. Any notable deviation from normal is considered pathological and is evidenced by lack of filling of a part or all of the deep circulation and a positive filling of the superficial system and collaterals. It is stated that 90 per cent of phlebothrombosis starts in the veins of the calf muscles and spreads *via* the deep circulation. A common finding in thrombo-embolic disease is venous spasm, which is readily shown, as is the release of spasm following therapeutic measures.

Various common dangers of the procedure are discussed. The authors reported no complications in their series. It is felt that venography is useful in helping determine feasibility of ligation in acute thrombosis; the venous status in patients with chronic swelling of the legs of venous origin; the patency of deep circulation, so that therapy of varicosities may be undertaken without fear of occluding the only venous return. Venography was used for this last purpose only in cases with doubtful Trendelenburg tests. The procedure is useful, also, for outlining the condition of the veins after therapy.

Nine roentgenograms; 1 drawing.

WILLIAM G. JOHNSON, M.D.
Jefferson Medical College

Phlebography of the Lower Extremity. David C. Bull. S. Clin. North America. **28:** 541-544, April 1948.

The technic described by the author for phlebography calls for the introduction of a Lindeman needle cannula usually in the saphenous vein, while the patient is still on the ward; with the obturator in place, the cannula can be left in indefinitely. Two x-ray tubes are used, placed at the usual 32-in. distance, with the upper one-half of the field over the Bucky diaphragm and the lower over a simple cassette. Forty cubic centimeters of 35 per cent diodrast are injected rapidly and the distal exposure is made. The cassette is immediately withdrawn and the second tube exposure made within five seconds of the first. Another cassette is slipped behind the knee and the patient turned on his side for a lateral view.

The author has been unsuccessful in the use of tourniquets; even with a blood pressure cuff obstructing the saphenous vein, he has found it difficult to avoid some compression of the deep veins. If it is desired to shunt the fluid into the deep vein, digital pressure is used at the previously marked site where the saphenous vein crosses the femoral condyle.

When the films have been exposed, saline is washed

through the system and the obturator is replaced in the cannula. The patient then awaits the developing of the films. If the wet films are unsatisfactory, the same cannula is available and the procedure may be repeated immediately or a few hours later.

The author points out that for interpretation of the films, it must be realized that in direct phlebography, the contrast medium takes the shortest, easiest route to the heart, and does not diffuse through the entire system as it would if the injection were done through the artery; therefore, if the internal saphenous vein of the ankle is used, failure to visualize the femoral does not necessarily mean occlusion unless an appropriate block has been used to shunt the fluid into the deep system. On the other hand, if the short saphenous is used, the fluid should go directly into the femoral and absence of this shadow is significant. S. F. THOMAS, M.D.
Palo Alto, Calif.

Thrombosis of the Inferior Vena Cava Due to Hypernephroma. Martin M. Fisher and Norton D. Ritz. Arch. Int. Med. **81:** 465-475, April 1948.

The case of thrombosis of the inferior vena cava due to hypernephroma reported here demonstrates the possibility of confusing cirrhosis of the liver with obstruction of the inferior vena cava because of dilated abdominal veins. In this case, the venous thrombosis was unusual, extending from the femoral veins through the inferior vena cava to the right auricle.

The author emphasizes the importance in all cases of dilatation of the abdominal veins of ruling out obstruction of the inferior vena cava. More extensive use of venography, with abdominal compression, should be encouraged.

Three roentgenograms; 1 photograph.

Radioactive Sodium in Peripheral Vascular Disease Studies. Beverly C. Smith and Edith H. Quimby. S. Clin. North America **28:** 304-323, April 1948.

This article represents a further elaboration on previous reports by the same authors (Science **100:** 175, 1944; Surg., Gynec. & Obst. **79:** 142, 1944; Radiology **45:** 335, 1945; Ann. Surg. **125:** 360, 1947). It includes a detailed presentation of 15 cases illustrating the uses of radioactive sodium in peripheral vascular diseases for prognosis; for determining the site of amputation below the knee when the main arteries are not palpable; for demonstrating increase (or no increase) in blood flow following local nerve block.

The authors now have a system of grading of one to four, which gives one a quick method of realizing the status of the circulation at any given time.

S. F. THOMAS, M.D.
Palo Alto, Calif.

MISCELLANEOUS

Multiple Calcinosis Associated with Hypervitaminosis D. Report of a Case. George McLean and Lester Lebo. South. M. J. **41:** 389-394, May 1948.

A 56-year-old white male had renal insufficiency, anemia, and multiple areas of metastatic calcinosis which the authors attribute to excessive Vitamin D therapy for osteoarthritis of the spine. The patient consumed a daily total of 150,000 international units of vitamin D and 180,000 units of vitamin A over a period of two and a half years.

Roentgenograms revealed calcification of the aorta and peripheral vessels. There was a large calcific mass in the soft tissues about the right hip and scattered calcific deposits were present in the soft tissues of the left lower forearm and hand. The gallbladder and gastro-intestinal studies were entirely negative, but poor function of both kidneys was noted on intravenous urography.

Serum calcium and phosphorus were within normal limits, but the Sulkowitch test was 2 plus. The acid phosphatase was high, but this is unexplained. A moderate anemia was present.

Following withdrawal of vitamin D, the patient was able to metabolize calcium efficiently, and the previously described calcific deposits disappeared. There was no longer any evidence of anemia and renal function definitely improved.

Eight roentgenograms EDWARD E. LEVINE, M.D.
Dearborn, Mich.

Roentgenologic Evidence of Biliary Regurgitation: Roentgenologic Contributions to the Diagnosis of Hypoparathyroidism; Appendicitis; Mesenteric Thrombosis. Harry M. Weber. Am. J. M. Sc. **215:** 568-576, May 1948.

This paper is a review of recent radiologic contributions to the diagnosis of the conditions mentioned in the title. Much space is given to the papers of Rigler and Mixer on biliary regurgitation (Radiology **48:** 463, 1947) and of Camp on the significance of symmetrical calcification of the cerebral basal ganglia in the diagnosis of parathyroid insufficiency (Radiology **49:** 568, 1947).

RADIOTHERAPY

Ovarian Dysfunction in Young Women Treated with Low-Dosage Irradiation. Della G. Drips. Am. J. Obst. & Gynec. **55:** 789-798, May 1948.

The author emphasizes the effect of low-dosage irradiation in functional menstrual irregularities, especially those of the amenorrheic type. The technic, as it is described here, consists in giving to each ovary and to the pituitary gland through two temporal portals one sixth of a skin erythema dose, with the following factors: 200 kv., 20 ma., 0.75 mm. Cu and 1.0 mm. Al filtration; 50 cm. distance. The time necessary to deliver such a dose to each portal is five minutes.

The patients treated with this method are divided into two major categories, married patients and unmarried patients. Each category is divided into two subdivisions, patients who have amenorrhea due to pituitary failure and patients who have amenorrhea due to ovarian dysfunction. There were 123 married patients and 136 unmarried. In addition, 46 women who had normal menstrual periods were given irradiation for dysmenorrhea (24) and sterility (22).

Out of the 123 married women treated for amenorrhea, 34 (27.6 per cent) became pregnant directly after treatment. In a follow-up study, 82 stated that their menstrual periods were definitely more regular, and of

these 45 had been pregnant, having 67 full-term pregnancies, 10 abortions, and 2 ectopic pregnancies. One patient gave birth to a monster after a full-term pregnancy. Of the 136 unmarried women treated, 94 were definitely improved.

The present article concludes with an interesting "comment," in which the author stresses the following points: (1) Of the two groups of patients who have the amenorrheic type of menstrual irregularity, the group in which pituitary failure is considered to be responsible responds better to treatment unless the atrophy of the genital tract has become irreversible. (2) The best results are attained when amenorrhea has been present for less than six months. (3) In cases of the exogenous type of pituitary failure, general hygienic measures, administration of thyroid extract, and estrogens are sufficient to bring about return of the menses. (4) In the endogenous type, and in any pituitary failure when the period of amenorrhea has been more than a year, the above mentioned treatments are given, and low-dosage irradiation over the pituitary and ovaries is administered. (5) In the cases of primary ovarian dysfunction, thyroid extract is used to stimulate metabolism. Estrogens are also given cyclically, sometimes with application of heat to the pelvis. If these measures fail, low-dosage irradiation is given over the ovaries alone. If the woman is not having hot flushes, irradiation over the pituitary is added.

There have been no significant side effects with this method of therapy: slight nausea is often experienced after irradiation, and a few women have temporarily lost the hair over areas where the treatment was given. No interference with the production and secretion of the pituitary is feared; at least, no case has been reported to the knowledge of the author.

Six tables.

WAHID SAWWAF, M.D.
Jefferson Medical College

Hemothorax in Relation to Benign Pelvic Tumors. Albert E. Long. California Med. **68:** 383-387, May 1948.

A case is reported of an ovarian tumor, with both masculinizing and feminizing features present in the clinical syndrome. The histologic picture, indistinct because of irradiation changes, was compatible with both arrhenoblastoma and granulosa-cell tumor; it should probably be classified as a mesenchymoma. Ascites and bloody pleural fluid were also present, with no metastases; the effusions disappeared after removal of the tumor following irradiation.

Three previously reported cases of hemothorax occurring in conjunction with benign pelvic tumors are reviewed, and a short discussion is given of the theories of the origin of the effusions, the radiosensitivity of granulosa-cell tumors, and the genesis and hormonal influence of these and allied tumors.

It seems apparent that:

(1) The presence of hemothorax in association with pelvic tumors is not necessarily indicative of malignancy.

(2) Surgical operation is indicated unless advanced malignancy is proved.

(3) Preoperative irradiation of pelvic tumors may be extremely useful when immediate operation is not judicious.

(4) Mesenchymomas may cause masculinizing or feminizing changes, or both; the predominant type of cell seen in the tumor may not correspond to the clinical syndrome.

Five photomicrographs.

Epithelial Bladder Tumors Attacked by Radons and Fulguration During the Years 1926–1938. Edward L. Keyes. J. Urol. **59:** 875–878, May 1948.

The author reports a series of 111 cases of epithelial bladder tumors. Thirty-six patients died within five years of onset; 26 were lost to follow-up; data on 7 were insufficient, and 42 were followed five years or longer. Of this last group, 23 were treated by radon; whether they received fulguration also is not definitely stated. There are four recurrences recorded in this group, the remainder being free from disease five to twenty years. Ten of the tumors were classified as papilloma or grade I; 6 as grade II; 3 as grade III; 4 as grade IV. The best results were obtained in those cases treated with radon.

One chart; 1 table.

PAUL R. NOBLE, M.D.
University of Pennsylvania

Tumors of the Testicle. Hans R. Sauer, Ernest M. Watson, and Eugene M. Burke. Surg., Gynec. & Obst. **86:** 591–603, May 1948.

A review of 202 testicular tumors observed during a twenty-five-year period is presented. In accordance with the simplified classification of the Army Institute of Pathology (Friedman and Moore: Mil. Surgeon **99:** 573, 1946), the 202 tumors were grouped as follows: 94 seminomas (46.9 per cent), 70 embryonal carcinomas (34.6 per cent), 3 choriocarcinomas (1.5 per cent), 27 teratocarcinomas (13.4 per cent), 5 adult teratomas (2.5 per cent), and 3 miscellaneous tumors (1.5 per cent).

The average age in this series was thirty-three years. Over two-thirds (67.9 per cent) of the patients were between twenty and forty years of age.

Enlargement of the testicle represented the most common complaint. Painless swelling was associated more frequently with seminomas, while painful enlargement occurred more often with embryonal carcinomas or teratocarcinomas. A history of coincidental trauma was elicited from 39 patients. Thirteen or 6.8 per cent of the group had cryptorchidism, a somewhat lower incidence than is usually reported.

The history of an insidious, though sometimes rapid, enlargement of the organ, often associated with a dragging sensation on the affected side should arouse one's suspicion, and, if examination reveals a smooth or, in some instances, an irregular mass, which can usually be differentiated from the epididymis, the lesion should be considered malignant until proved otherwise. Exploratory operation, and not watchful waiting, is the procedure of choice if the diagnosis is in doubt. In no case should biopsy or needle puncture be resorted to as a means of establishing the diagnosis, because such a procedure would destroy the continuity of the capsule and facilitate dissemination of tumor cells.

Metastases occurred in 117 or 57.9 per cent of the cases. Their incidence was highest in patients with embryonal carcinoma (72.9 per cent) and lowest in those with seminoma (50 per cent). While metastases from seminomas remained quite often confined to the abdomino-aortic nodes, it was the rule that embryonal carcinomas and teratocarcinomas metastasized also to the parenchymal organs.

Orchiectomy with regional lymph node dissection, followed by deep x-ray therapy, is advocated in the treatment of radioresistant testicular tumors and simple orchiectomy plus irradiation is preferred for the more radiosensitive seminomas.

Indications, technic, and dosage of irradiation therapy of testicular tumors are discussed. Postoperative roentgen irradiation is indicated in all cases, regardless of the presence or absence of metastases. If no metastases are demonstrable, treatment is given over three areas; the lower abdomen and groin on the side of involvement, epigastrium, and mediastinum. Not less than 2,000 r (with back-scatter) should be delivered to the depth of each of these areas in cases in which histologic and biologic behavior suggest radiosensitivity. A larger dose is indicated for more radioresistant lesions. If distant metastases are present, these should be treated first. In cases in which metastases are found in the mediastinum or abdomino-aortic nodes, irradiation should first be given to the lesion at the greatest distance from the primary tumor. During treatment the effect of x-ray therapy on the metastatic lesions must be evaluated by daily examinations, supplemented by roentgenography when necessary, and the plan of treatment modified as required by response to treatment. It is imperative to deliver in one course an adequate amount of radiation to metastases. The authors do not consider a dosage of less than 2000 r as adequate in the treatment of metastases, and they prefer doses of 2,500 to 3,500 r. In the presence of metastases, favorable end-results are obtained almost entirely in patients with seminoma and those with embryonal carcinoma plus seminoma. In contrast, response to irradiation is generally poor in patients with metastases from the other types of testicular neoplasms.

The end-results obtained are presented: Ninety-six patients (47.5 per cent) are alive and well, 2 are alive with disease, 95 died of the disease, 3 died of other causes, and 6 were lost trace of. The 5-year cure rate was 48.9 and the 10-year cure rate 34.7 per cent.

The following pattern of prognosis is presented. The prognosis is best in patients with adult teratomas or seminomas, particularly those that contain lymphoid stroma. It is less favorable in patients with teratocarcinoma or patients with embryonal carcinoma plus seminoma. The outlook is much more unfavorable in patients with tumors consisting of embryonal carcinoma with or without admixture of choriocarcinoma, and even worse in patients with plain choriocarcinoma.

Twelve illustrations, including 4 roentgenograms; 8 tables.

JOHN W. HOPE, M.D.
University of Pennsylvania

Some Considerations Regarding the Treatment of Hemangiomas. Richard H. Chamberlain, and Eugene P. Pendergrass. Pennsylvania M. J. **51**: 867–869, May 1948.

Hemangiomas of the skin may be divided into (1) flat tumors, (2) hypertrophic angiomas, (3) cavernous hemangiomas. In the flat type, the light colored lesions are radiosensitive, but the dark port-wine stains are quite radioresistant.

Treatment should be begun as early in life as possible, as it is the experience of the authors that there is very little tendency to spontaneous regression. In the flat type of lesion, low-voltage therapy (45 or 48 kv.) with the Philips or Chaoul type of machine, is used. A dosage of 200 to 300 r (in air) is given every six weeks to two months. Some cases need only two or three treatments. Others are given larger doses, but a total of 2000 r is never exceeded. Where a deeper venous element exists, 0.5 millicurie radon seeds are employed. Multiple low-strength seeds are preferred over large seeds of greater strength.

One drawing; 1 graph.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Radiotherapy for Plantar Warts. A. Sobel and P. Sobel. J. de radiol. et d'électrol. **29**: 122, 1948. (In French)

The authors report successful treatment of about 300 cases of plantar warts. The following technic was employed: 120 kv., 2 mm. aluminum filtration, 3 ma., and 30 cm. distance. The total dose was 2,000 r given in three sessions, two of 750 r each and one of 500 r, at intervals of two days. In 90 per cent of cases, the wart disappeared between the twenty-fifth and thirtieth day. If cure did not result, an additional dose of 750 r was given. In rare cases, treatment had to be repeated at the end of three months. No complications were encountered.

RODERICK L. TONDREAU, M.D.
The Mayo Foundation

Ringworm of the Scalp. Review of 100 Cases. Donald M. Ruch. Wisconsin M. J. **47**: 385–387, April 1948.

One hundred cases of tinea capitis are reviewed with reference to age, sex, type of infection, family incidence, and frequency of involvement of the various regions of the scalp. Ninety-seven cases were of the gray scaly patch type (*Microsporum audouini*) and 3 of the kerion type (*Microsporum lanosum*). Data are based on 91 cases that could be followed adequately; 67 cases were cured, 9 improved, and in 15 treatment failed. Three main types of treatment were employed: x-ray epilation, manual epilation, and topical therapy.

In the kerion type of infection x-ray epilation is not necessary because the inflammation is so intense that spontaneous epilation occurs. All three patients in this group were cured by topical applications.

Of the 88 patients with the gray scaly patch, x-ray epilation was used in 61, manual epilation in 8, and local therapy alone in 19. Forty of the 61 patients receiving x-ray treatment were first subjected to local therapy consisting of fungicidal wet dressings and ointments. These measures were ineffective and the remaining 21 patients received only x-ray therapy. Manual epilation was ineffective in 4 of the 8 cases in which it was done.

RADIATION EFFECTS

Value of Platelet Counts in Radiotherapy. W. M. Court Brown. Brit. J. Radiol. **21**: 221–225, May 1948.

On serial studies in patients receiving wide-field roentgen irradiation it was found that the platelet count and the white count were at first parallel; later the white count tended to rise even in the presence of continued therapy but no secondary rise in platelets occurred. The platelet count is therefore considered a

better indicator of bone marrow damage than the white count. Wide-field irradiation is not undertaken when the initial platelet level is below 100,000 per c. mm. There is no relation between the platelet count and the white count in the leukemias.

Two graphs; 2 tables.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Sarcoma Arising in Irradiated Bone. Report of Eleven Cases. William G. Cahan, Helen Q. Woodard, Norman L. Higinbotham, Fred W. Stewart, and Bradley L. Coley. Cancer **1:** 3–29, May 1948.

The development of sarcoma in bone that has been exposed to heavy doses of roentgen rays or radium is uncommon; it may occur either in a benign tumor or in normal bone. Eleven such cases are reported by the authors. A long latent period following exposure of the bone to irradiation is required for the sarcoma to develop; in the cases here presented, it ranged from six to twenty-two years. Bone sarcoma is seldom seen after moderate doses of radiation and probably requires a tissue dose of 3,000 r. In one of the authors' cases the sarcoma followed a tumor dose of 1,550 r.

There is no satisfactory explanation for the fact that so few sarcomas develop in the thoracic cage after heavy irradiation in breast cancer, or in the pelvic bones after irradiation for cancer of the uterus. It may be that such developments have been confused with metastatic carcinoma. Nor has sarcoma been observed frequently in the intensely irradiated facial bones and jaws in patients with cancer of the mouth, jaws, neck, etc. Perhaps few of the latter survive sufficiently long.

When a patient complains of pain, with or without swelling, in an area that has been treated by irradiation for a benign bone lesion five or more years previously, the authors believe malignant change should be suspected. Roentgenograms should be made at once and biopsy material obtained, preferably by aspiration, to avoid incision of the irradiated tissues.

The tardy development of bone sarcoma after irradiation is another argument against roentgen therapy for non-malignant bone tumors. Although uncommon, it has most serious implications when it does occur. Treatment should consist in immediate wide surgical removal either by resection or by amputation. Since giant-cell tumors have inherent tendencies to undergo alteration in their histologic appearance and clinical behavior, it seems advisable to avoid, wherever possible, the use of an agent (roentgen rays) that may of itself provoke malignant change.

Eighteen illustrations (11 roentgenograms); 3 tables.

Radiation Injuries of the Intestines. Charles W. Hock, Jose Rodrigues, Anna Hamann, and Walter Lincoln Palmer. Am. J. Med. **4:** 511–524, April 1948.

Radiation injury of the intestine occurred in 19 patients in a series of 344 cases of carcinoma of the female reproductive system seen at the University Clinics, University of Chicago. In 16 patients the carcinoma involved the cervix and in 3 the uterus. Four of the women received radiation therapy elsewhere and came for treatment of the complications. In several additional cases the presence of carcinoma immediately adjacent to the site of irradiation made it impossible to evaluate the degree of radiation injury, if any; these have not been included.

The outstanding early symptom of radiation injury of the intestine is diarrhea, mild to severe in degree. Later manifestations are pain, demonstrable ulceration, and stricture formation with partial or complete obstruction. The early lesions, located usually on the anterior wall of the rectum and rectosigmoid, are characterized by an edematous friable mucous membrane. Later ulceration, with a grayish white slough, occurs at the level of the cervix. In time, perirectal fibrosis resembling a "frozen" pelvis may develop and result in obstruction.

Roentgen studies are advisable when proctoscopy does not reach the lesion or when endoscopy is impossible. Barium enema or barium and air double-contrast studies are much more satisfactory than the barium meal. Characteristic roentgenograms are reproduced. Biopsy is somewhat hazardous because of the danger of perforation and fistula formation. The decisive diagnosis between neoplasm and radiation injury may finally be made only by the improvement in general health following adequate treatment, relief of the intestinal symptoms, and roentgen evidence of increasing size of the lumen of the bowel.

In the treatment of the acute reactions, symptomatic medical treatment is usually satisfactory. Rest in bed, a bland diet, rectal instillations of warm oil, antispasmodics, and sedatives are helpful. The more severe cases should be treated very carefully; dehydration and metabolic changes must be combated by means of parenteral fluids, saline, glucose, and protein as indicated. Direct treatment of the rectal lesion by irrigations with saline or weak antiseptics is probably of little value. Surgery may be required because of stenosis, bleeding, or pain. A colostomy is imperative when the stenosis is marked. With incomplete obstruction due primarily to edema, conservative management may afford relief. Recurrent bleeding is occasionally severe enough to require colostomy. In some cases both colostomy and presacral sympathectomy for relief of persistent severe pain may be required.

The ideal therapy is, of course, prophylactic, the avoidance of radiation injury. Whether or not it is possible by attention to the details of technic to administer effective carcinocidal doses of irradiation without occasional severe injury to adjacent normal tissue such as the rectum seems questionable at present.

Four roentgenograms; 2 photographs; 3 photomicrographs; 2 tables.

Rectal Hemorrhage Following Irradiation for Carcinoma of Cervix. James R. Johnston and Harold W. Jacox. Am. J. Obst. & Gynec. **55:** 891–893, May 1948.

Irradiation for pelvic cancer frequently results in damage to the distal colon, varying from a simple proctitis through stages of destruction terminating in atrophy, stenosis, or perforation. These changes often are on the basis of obliterative endarteritis or telangiectasia. Rectal hemorrhage occurs on an inflammatory basis and usually responds to medical care, but at times a colostomy is necessary to relieve the condition. A case is reported of severe, intractable rectal hemorrhage which necessitated not only colostomy but even excision of the distal sigmoid and rectum to stop the bleeding. The patient was treated twice with radium followed by two pelvic x-ray series for carcinoma of the uterine cervix. One year later there developed severe rectal bleeding which required resection of the terminal large bowel. Microscopic section revealed metastatic car-

cinoma of the submucosa of the colon. A year later a clinically silent primary carcinoma of the ascending colon developed, which was treated surgically. Ten years after the original cervical carcinoma the patient is in excellent health without recurrence of either neoplasm.

CHARLES W. WERLEY, M.D.
Jefferson Medical College

Disfiguring Sequelae from Radium Therapy. Results of Treatment of a Birthmark Adjacent to the Breast in a Female Infant. G. B. Underwood and L. Edward Gaul. Arch. Dermat. & Syph. **57:** 918–919, May 1948.

The case is reported of a girl of twelve years, whose left breast developed to only about one-fourth normal size following radium therapy, in infancy, of an angioma cavernosum, 6 cm. in its greatest diameter, topped by a nevus vasculosus, 1 cm. in diameter. The tumor impinged on the inferior border of the breast, but did not involve the areola or the nipple. Fifty mg. of radium, filtered with 1 mm. of brass at a distance of 1 cm., had been applied over the tumor for seven hours at the age of three months. This was followed, after an interval of two and a half months, by a contact exposure of 35 mg. of radium to each 2 cm. of area, filtered with 1 mm. of brass and 2 mm. of rubber. Two months later the tumor had disappeared.

MacKee, in a personal communication to the authors, stated that this case is unique in his experience and "represents a lack of glandular development caused by irradiation, in spite of conventional dosage, or a coincidence consisting of congenital lack of development, or the angioma involved the gland tissue of the breast in addition to the cutaneous and subcutaneous tissue."

One photograph.

EXPERIMENTAL STUDIES

Experimental Pyelorenal Reflux. Giacinto Piccolo and Giuseppe Longo. Radiol. sperimentale **2:** 68–79, January-February, 1948. (In Italian)

The authors have measured the secretory pressure of urine in dogs following operative insertion of a cannula in the ureter. They found that at the end of an hour, the urine reached pressure between 50 and 100 mm. of mercury. Intravenous injection of caffeine or of uroselectan B produced a further rise of 20–40 mm.

In three animals, contrast medium was injected in the ureter itself (simulating retrograde pyelography) with pressure as high as 300 mm. of mercury. Only one of these animals showed a pyelorenal reflux. It is concluded that reflux can be expected only if the pressure of ureteral injection greatly exceeds the normal secretory pressure of the kidney.

Eleven roentgenograms.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Bone Changes in the Cat in Experimentally Produced Injury to the Peripheral Nerves. M. A. Schiller. J. Bone & Joint Surg. **30A**: 469–473, April 1948.

The author quotes extensively from the literature on peripheral nerve injury with accompanying bone changes. He himself examined the bone in a large group of cats who had had the sciatic nerve severed, to show any changes that may have occurred in the bone. In some of the animals cutaneous ulcers developed and in many of these definite but slight atrophy of the tarsal structures could be demonstrated. The criteria of bone atrophy were general demineralization and preservation of density in the articular cortex. No bone changes were demonstrated except when ulceration was present in the heel or knee. Immobilization of the extremity was more likely to be followed by ulceration and bone atrophy.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Penetration of Gamma-Radiation through Thick Layers. I. Plane Geometry, Klein-Nishina Scattering. J. O. Hirschfelder, J. L. Magee, and M. H. Hull. **II. Plane Geometry, Iron, and Lead.** Joseph O. Hirschfelder and Edward N. Adams II. Phys. Rev. **73:** 852–868, April 15, 1948.

In the first of these papers formulae are developed for absorption by multiple scattering and tables are furnished, which, however, are not of much use to the clinical roentgenologist. Figure 6 shows nicely the proportions of unscattered, singly scattered, up to quadruply scattered rays at increasing thickness for million-volt gamma rays. [Monochromatic x-rays would be the same.]

In the second contribution, photoelectric effect and pair production are taken into account. The formulae and Tables I and II are hardly useful to the clinical radiologist. Table III gives the increasing absorption coefficients as attenuation increases with great thickening of the absorbing layer from a transmission of 1/2 down to a transmission of 10^{-6}; this for 1, 3, and 5 Mev. gamma rays and for water, concrete, iron, and lead. Energy flux and roentgens per unit time do not run parallel. Formula and table for this correction are given. Table I gives transmission in roentgens for several thicknesses of lead (up to 35 cm.) and iron (up to 43 cm.). Photoelectric absorption becomes negligible above 100 kv. for aluminum and above 1 Mev. for lead. Absorption in lead passes through a minimum at 2 1/2 Mev., increasing again at higher energies on account of increasing pair production.

R. R. NEWELL, M.D.
Stanford University Hospitals

umor im-
ut did not
f radium,
cm., had
at the age
n interval
sure of 25
ith 1 mm.
later the

e authors,
ience and
caused by
r a coinci-
pment, or
breast in
ssue."

and bone
, M.D.
Penna.

h Thick
cattering.
Hull. II.
. Hirsch-
73: 852-

eveloped
ables are
se to the
the pro-
to quad-
million-
ld be the

fect and
formulae
clinical
sorption
thicken-
n of 1/2
l 5 Mev.
nd lead.
not run
tion are
gens for
iron (up
egligible
for lead
at 2 1/2
count of
M.D.
pitals